FOR ERRATA

AD 412682

THE FOLLOWING PAGES ARE CHANGES

TO BASIC DOCUMENT

AD 412682

412682

R-5214

DESIGN INFORMATION REPORT FOR THE THOR YLR79-NA-13 MAIN ENGINE AND LR101-NA-11 VERNIER ENGINES

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.
6633 CANOGA AVENUE
CANOGA PARK, CALIFORNIA

Contract AF04(695)-306

Part I, Item 2b as
Amended by Item VI of
Request For Service
Order 306-64-03

PREPARED BY

Rocketdyne Engineering
Canoga Park, California

APPROVED BY

J. J. Griffin
Atlas/Thor Program Manager

NO. OF PAGES 79 & viii

DATE 30 July 1963

REVISIONS

DATE	REV. BY	PAGES AFFECTED	REMARKS
30 Jan 1964	WNP	7	Updated Drawing 104653

FORM R 18-G (PLATE)

FOREWORD

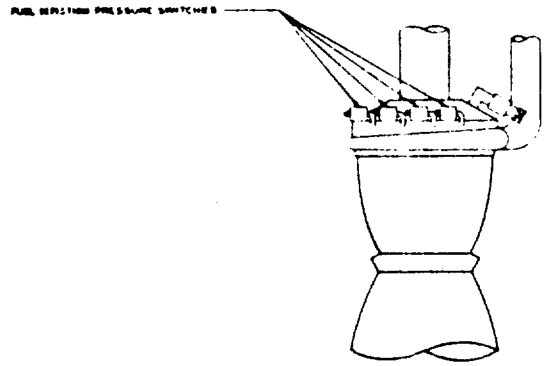
This Design Information Report was prepared in compliance with AF04(695)-306, Part I, Item 2b as amended by Item VI of Request for Service Order 306-64-03.

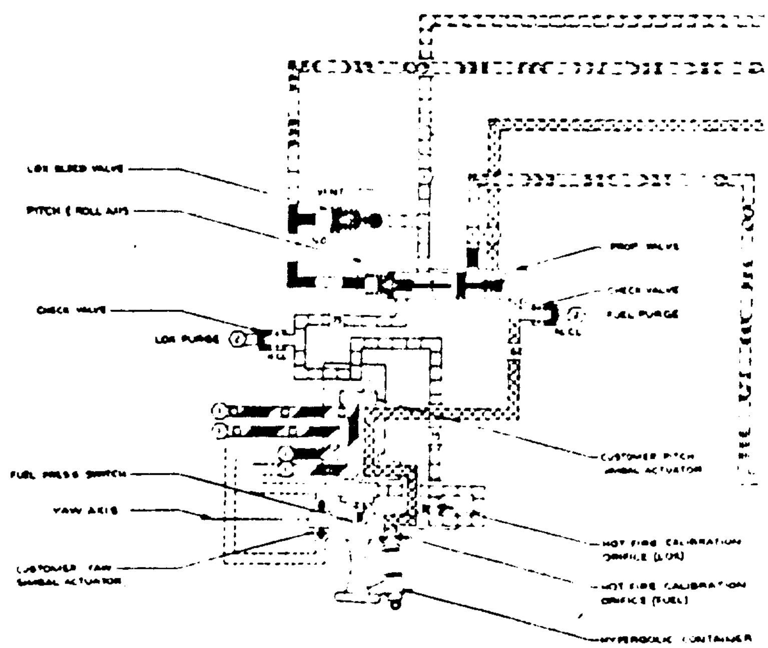
ABSTRACT

This report consists of three major sections: (1) a description of the LV-2A propulsion system, consisting of the YLR79-NA-13 main engine and the LR101-NA-11 vernier engines, (2) installation and geometry information, and (3) performance data.

CONTENTS

1


FUEL IGNITION PRESSURE SWITCHES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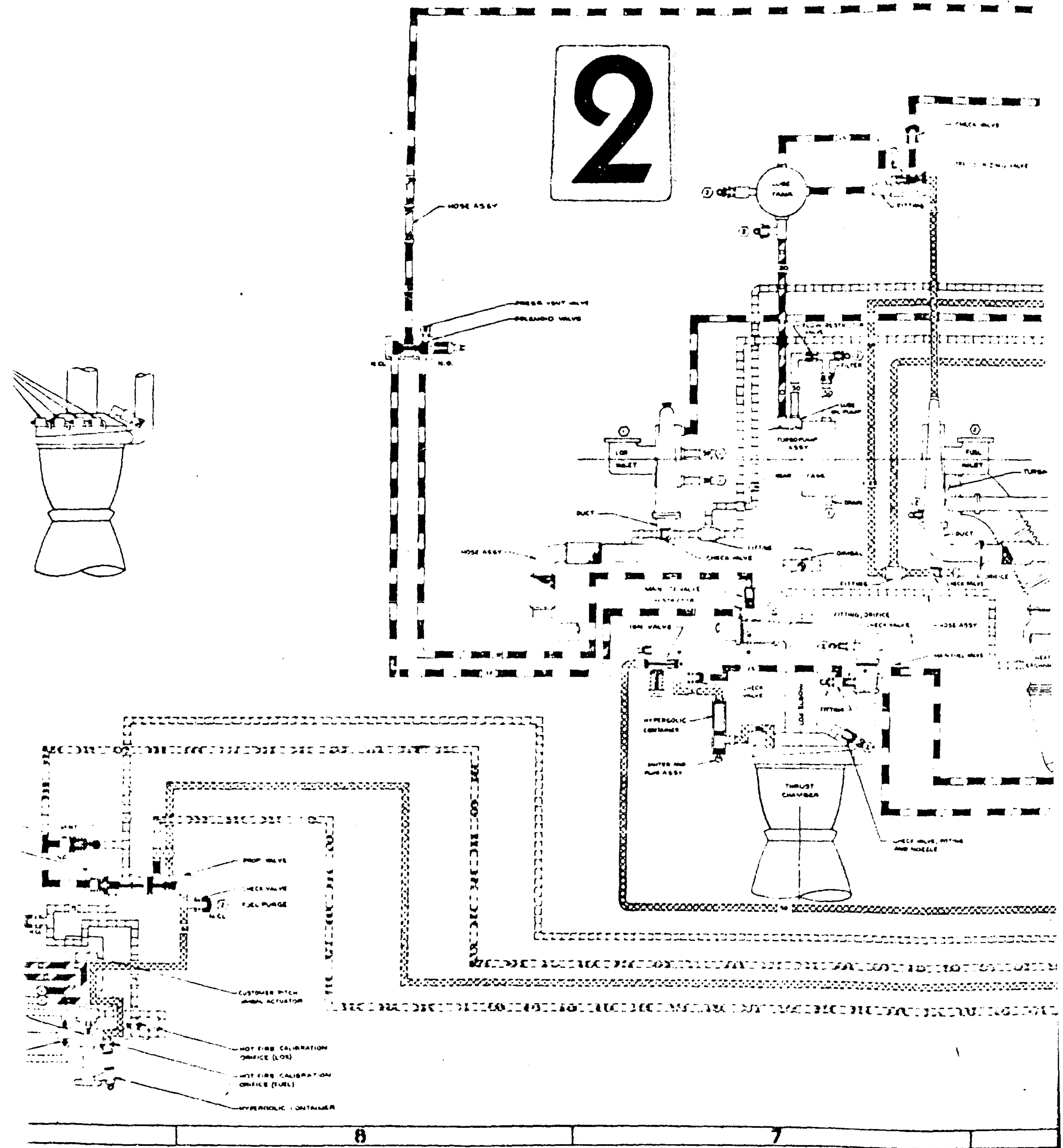
PITCH & ROLL AXIS
CHECK VALVE
LOX PURGE
FUEL PRESS SWITCH
YAW AXIS
CUSTOMER YAW GIMBAL ACTUATOR
PROP VALVE
CHECK VALVE
FUEL PURGE
CUSTOMER PITCH GIMBAL ACTUATOR
HOT FIRE CALIBRATION ORIFICE (LOX)
HOT FIRE CALIBRATION ORIFICE (FUEL)
HYPERGOLIC CONTAINER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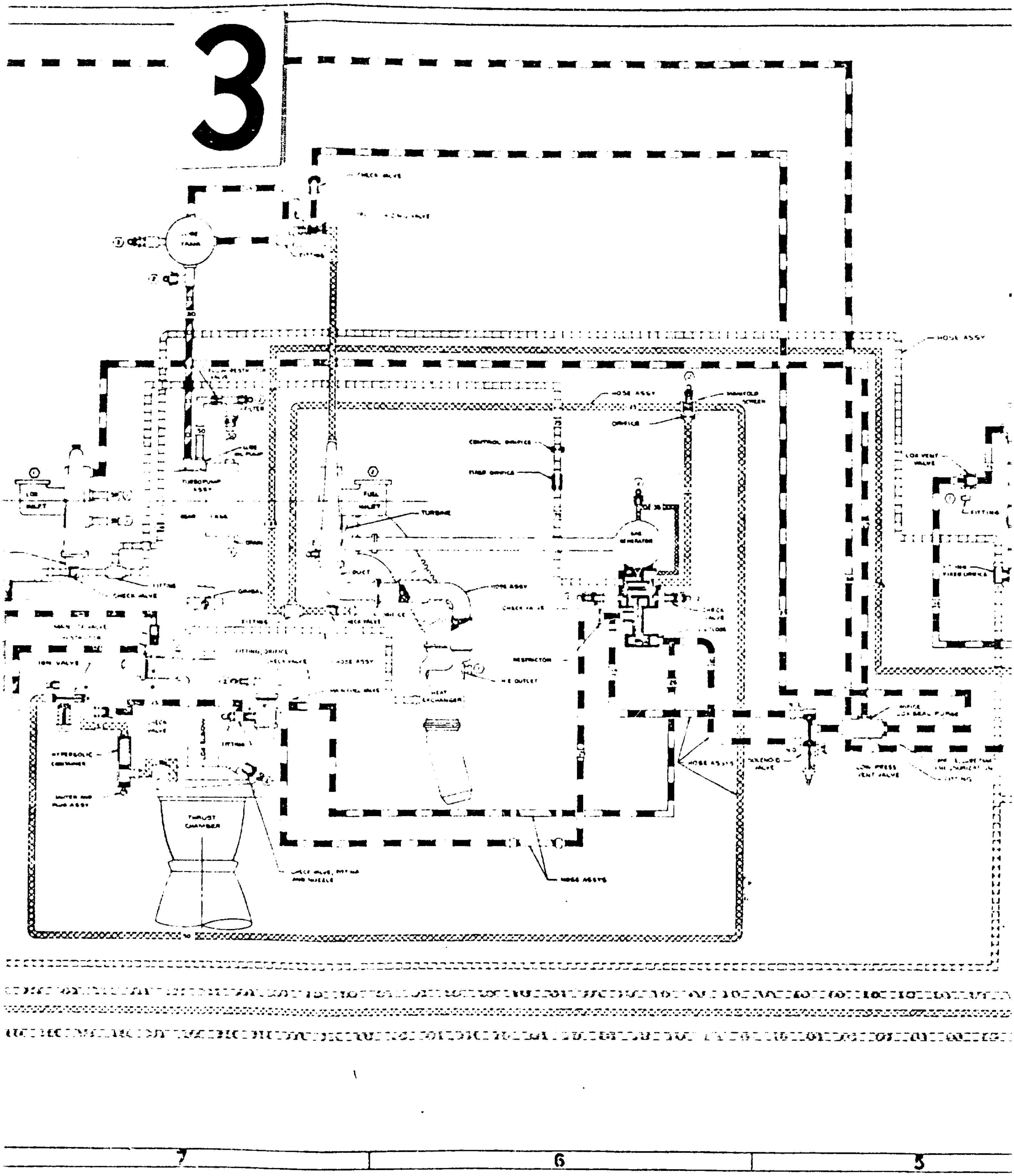
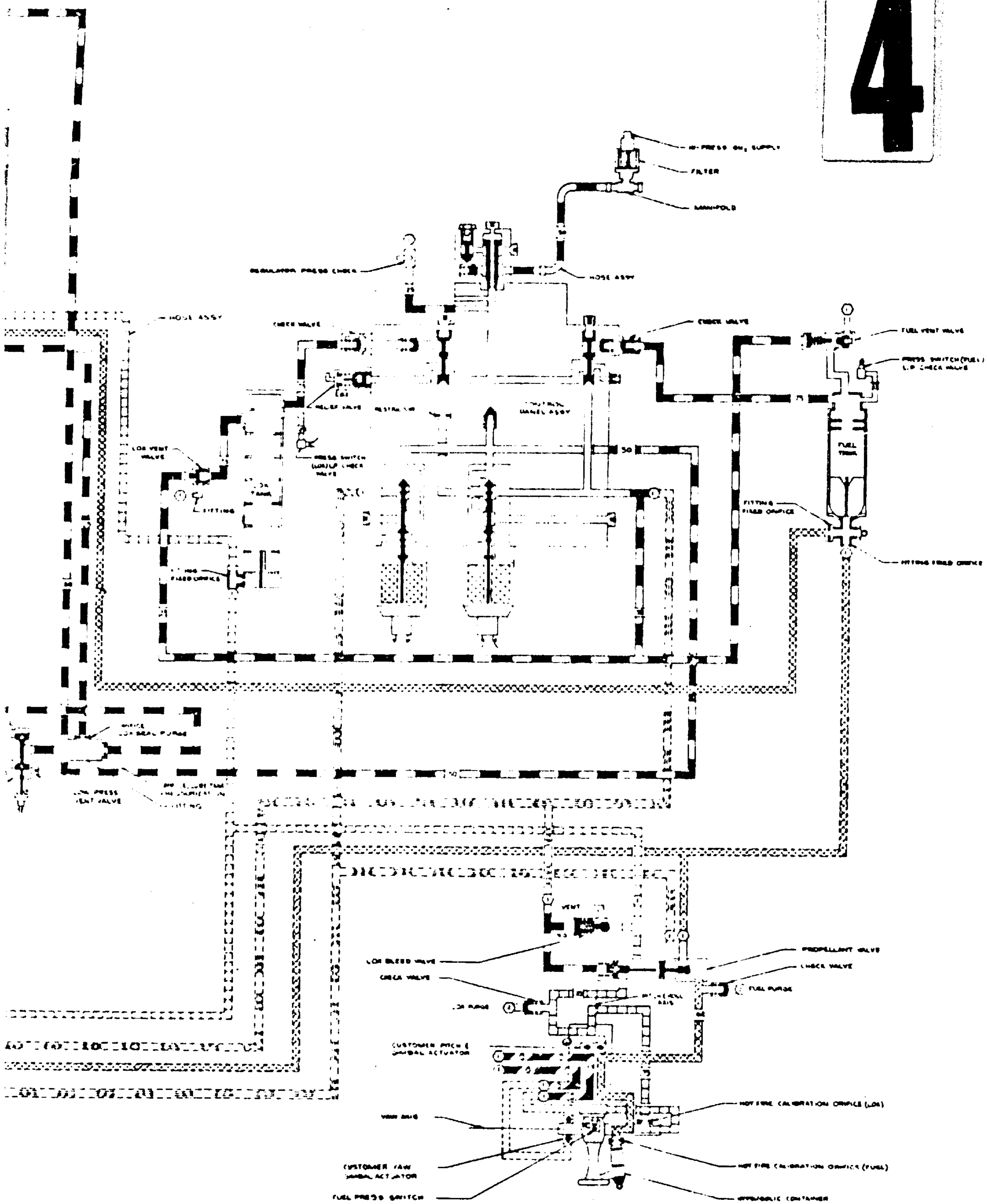
HOSE ASSY
PRESS. VENT VALVE
SOLENOID VALVE
N.O.
LUBE TANK
CHECK VALVE
FITTING
FILTER
TURBOPUMP ASSY
LOX INLET
FUEL INLET
DUCT
HOSE ASSY
CHECK VALVE
GIMBAL
FITTING
LOX VALVE
FITTING, ORIFICE
CHECK VALVE
HOSE ASSY
HYPERGOLIC CONTAINER
IGNITER AND FUSE ASSY
LOX ELBOW
THRUST CHAMBER
CHECK VALVE, FITTING AND NOZZLE
VENT
PROP. VALVE
CHECK VALVE
FUEL PURGE
CUSTOMER PITCH GIMBAL ACTUATOR
HOT FIRE CALIBRATION ORIFICE (LOX)
HOT FIRE CALIBRATION ORIFICE (FUEL)
HYPERGOLIC CONTAINER
8
7


3
CHECK VALVE
TURBOPUMP ASSY
LOX INLET
FUEL INLET
TURBINE
DUCT
FITTING
GIMBAL
HOSE ASSY
CONTROL ORIFICE
ORIFICE
MANIFOLD SCREEN
RESTRICTOR
HEAT EXCHANGER
HOSE ASSYS
THRUST CHAMBER
CHECK VALVE, FITTING AND NOZZLE
HYPERGOLIC CONTAINER
7
6
5

4



5 | 4 | 3

5

B	REDRAWN WITH CHANGES 1 REVISED FORMAT 2 ADDED SCHEMATIC CODE

SCHEMATIC CODE

HOT GAS
PNEUMATIC
HYDRAULIC
LUBE
OXIDIZER
FUEL

R-5214 7

2 SERVICE CONNECTIONS
1 CUSTOMER CONNECTIONS

SCHEMATIC,
ENGINE SYSTEM

02602 J 104553

104553

B

3 2 1

AD 412682

END CHANGE PAGES

63-4-4

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.
CANOGA PARK, CALIFORNIA

R-5214

DESIGN INFORMATION REPORT FOR THE LV-2A PROPULSION SYSTEM (YLR79-NA-13 Main Engine and LR101-NA-11 Vernier Engines)

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

6633 CANOGA AVENUE
CANOGA PARK, CALIFORNIA

Contract AF04(695)-306

Part I, Item 2b as
Amended by Item VI of
Request For Service
Order 306-63-01

PREPARED BY

Rocketdyne Engineering
Canoga Park, California

APPROVED BY

J. J. Griffin
Atlas/Thor/Jupiter Program Manager

NO. OF PAGES 79 & viii

DATE 30 July 1963

REVISIONS

DATE	REV. BY	PAGES AFFECTED	REMARKS

FORM R 18-G (PLATE)

FOREWORD

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ABSTRACT

This report consists of three major sections: (1) a description of the LV-2A propulsion system, consisting of the YLR79-NA-13 main engine and the LR101-NA-11 vernier engines, (2) installation and geometry information, and (3) performance data.

CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

The function of this report is to compile in handbook form the various items of engine design information in which the customer has expressed prime interest. It is also intended as an aid to design and to ensure compatibility of missile structure and the LV-2A propulsion system.

This report is not intended to supersede or duplicate existing model specification or Rocketdyne Field Service manuals.

Additions and revisions will be issued periodically to maintain this report on a current basis.

SECTION I: PROPULSION SYSTEM DESCRIPTION AND OPERATING REQUIREMENTS

PROPULSION SYSTEM DESCRIPTION

The LV-2A propulsion system (Fig. 1) is composed of a booster main engine (Air Force designation YLR79-NA-13) and two vernier engines (Air Force designation LR101-NA-11) which provide roll control and finite impulse adjustment at the end of flight. The complete propulsion unit is a liquid bipropellant system and operates on liquid oxygen and RJ-1 hydrocarbon fuel. The main engine has a maximum over-all length of 142.587 inches and a maximum envelope diameter of 76.117 inches. The engine is rated to deliver a thrust of 170,000 pounds under sea-level conditions for a mainstage duration of 175 seconds. An additional 2120 pounds total thrust is developed by the two vernier engines during pump-fed operation and 1660 pounds total thrust during tank-fed operation for approximately 9 seconds after main engine cutoff.

Both the main and vernier engines are of the single-start, fixed-thrust type with no provision for restarting the engines or for intermediate thrust control. System propellant flowrates are controlled exclusively by orificing. All thrust chambers are gimbal-mounted for trajectory control and adjustment. The main engine thrust chamber is provided with a baffled injector. Ignition in all chambers is by means of hypergolic fluid. The entire propulsion system is controlled by an electrical system and a pneumatic system. Nitrogen gas is used in the latter system to operate all pneumatically controlled valves. Electrical power to control the engines is supplied from an external source until the missile is airborne, after which the missile's electrical system supplies the required electrical power.

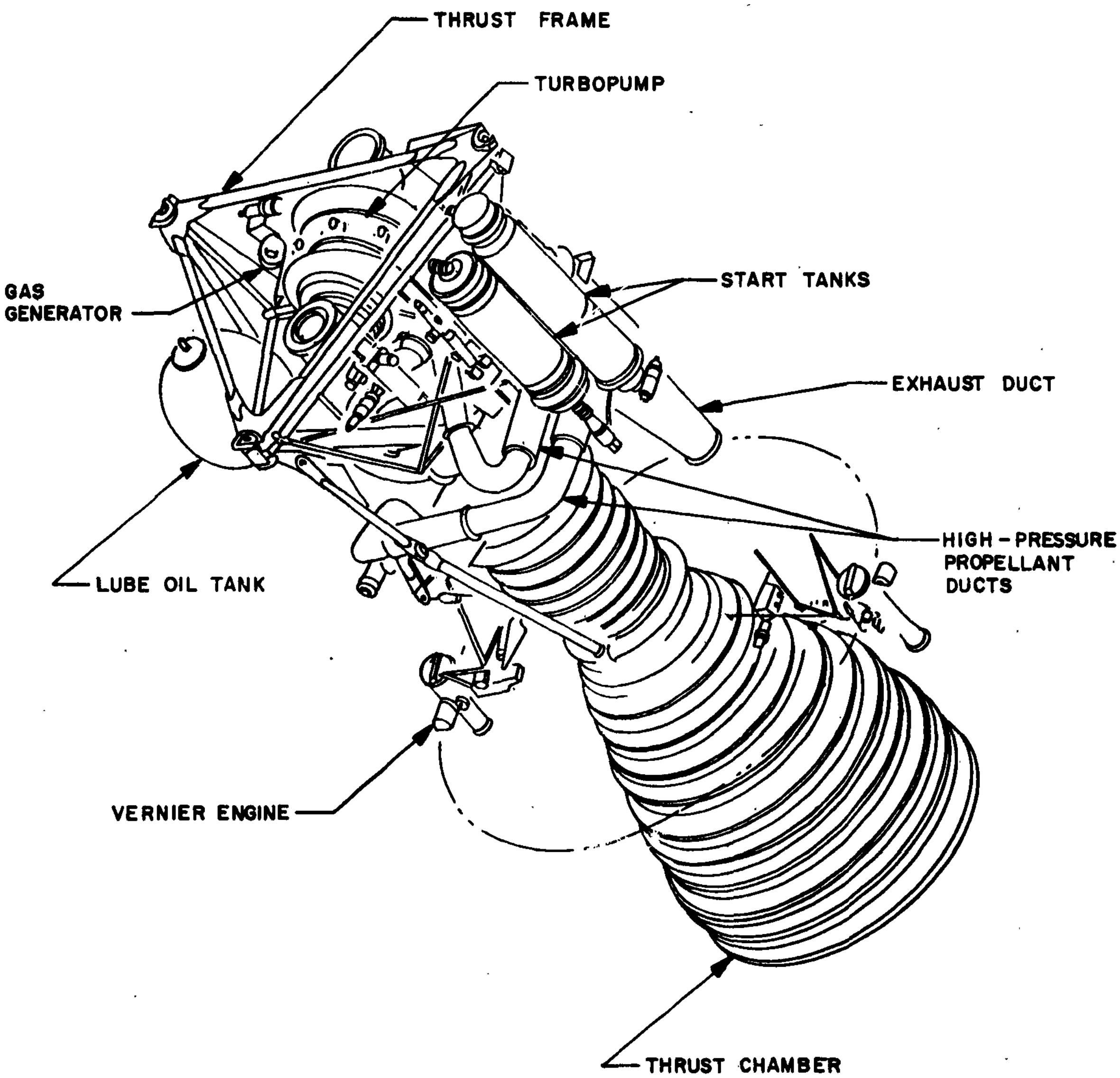


Figure 1. LV-2A Propulsion System

The turbopump for the main engine provides one accessory drive pad to be used for the attachment of missile accessories. The accessory drive pad is capable of delivering 100 horsepower for the intended flight duration. The accessory drive pad conforms to the Air Force-Navy Aeronautical Design Standard AND20002-X11-K, with the following exceptions:

1. Maximum speed is 4200 rpm; minimum speed is 3650 rpm.
2. Direction of rotation is counterclockwise facing the accessory drive pad.
3. No provision is made for lubrication of accessories.

One single-element heat exchanger for gasifying liquid oxygen to be used as LOX tank pressurant is installed in the turbopump exhaust duct.

A list of propulsion system installation drawings is given in Table 1 .

A schematic of the main engine and details of the control orifice locations are shown in Drawings 104653 and 408113. Control orifice locations for the LR101-NA-11 vernier engines are shown in Drawing 350670.

TABLE 1

LV-2A PROPULSION SYSTEM INSTALLATION DRAWINGS

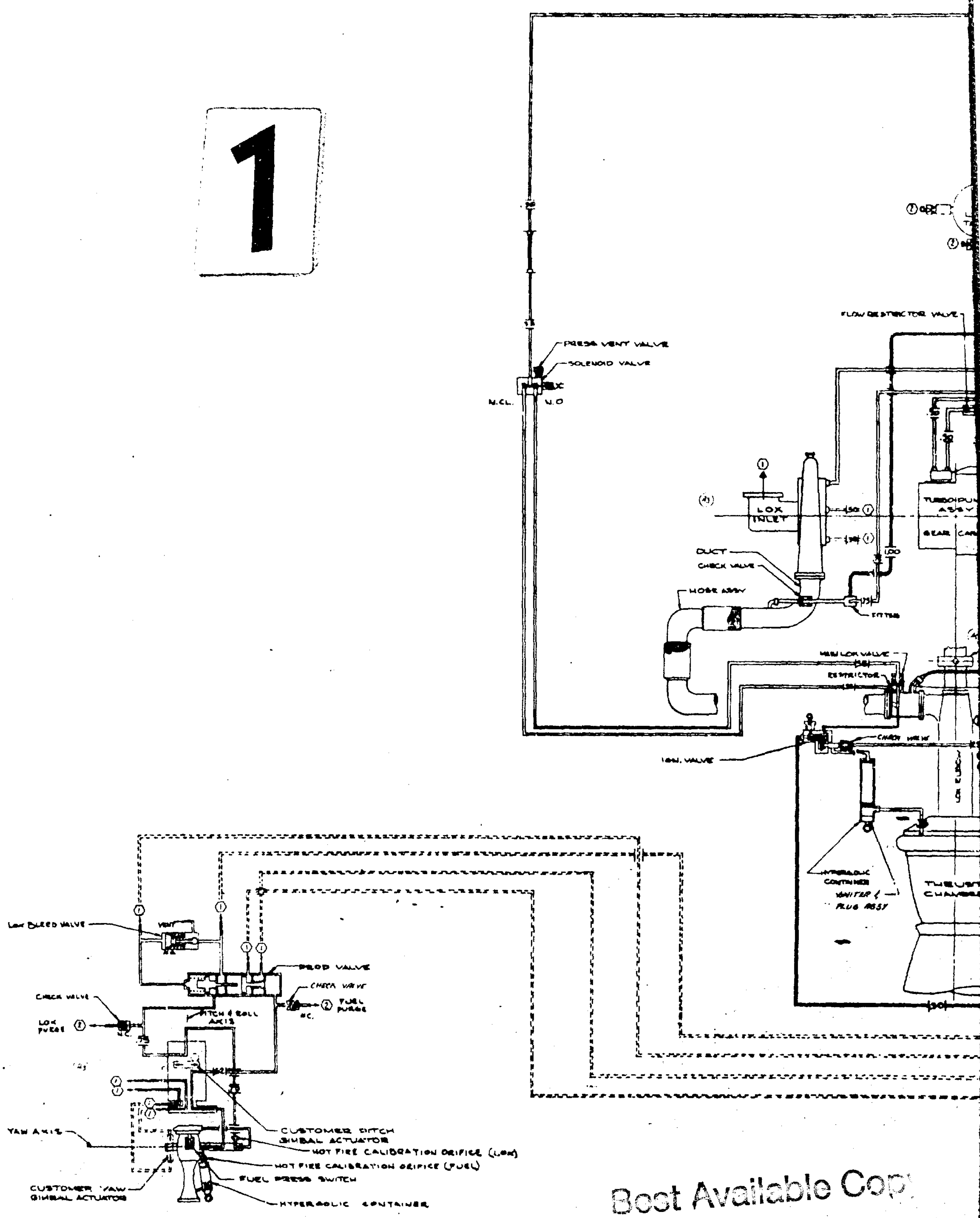
YLR79-NA-13 Main Engine

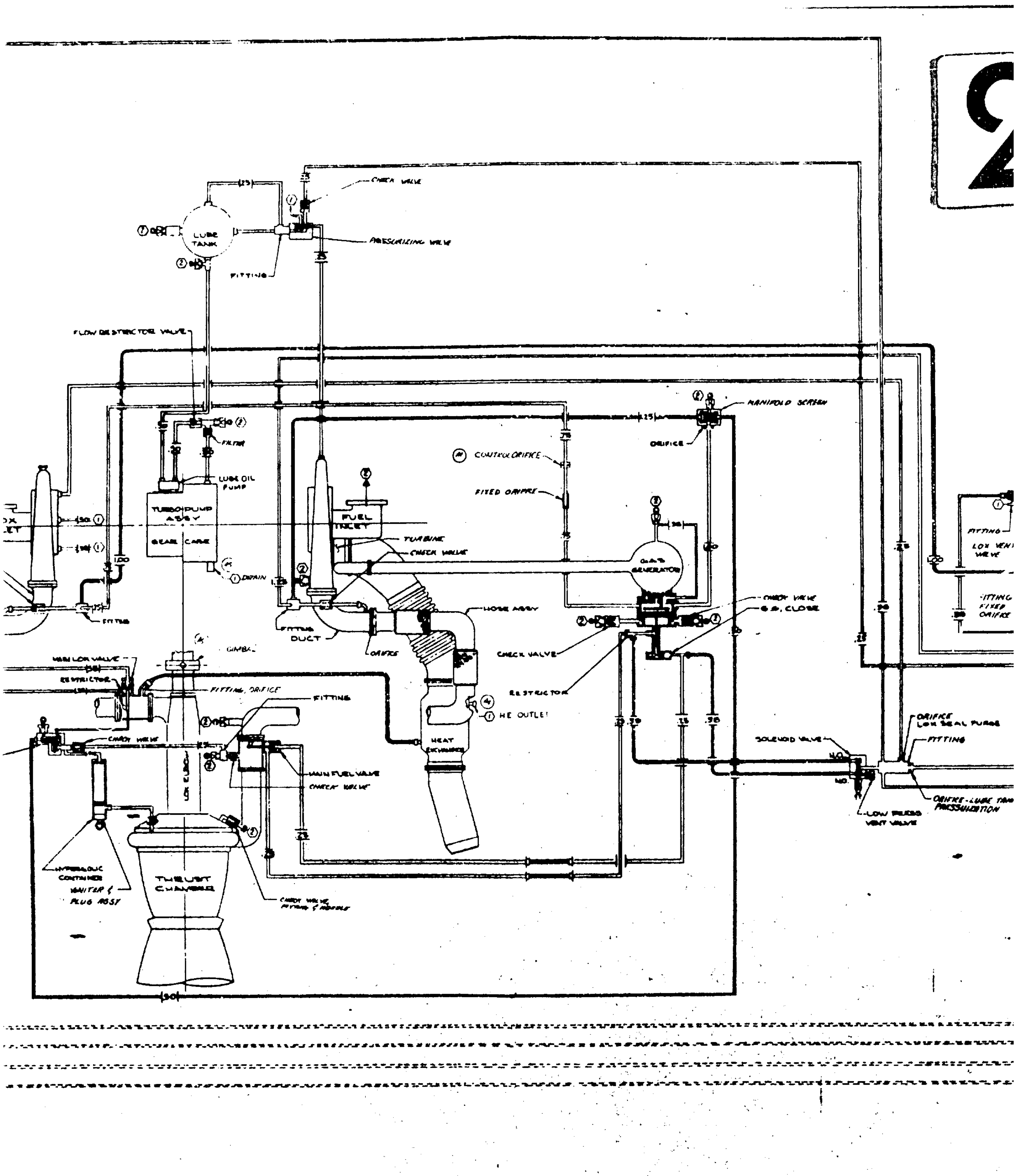
Engine Assembly Drawing	104651
Major Component Installation	104652
Start System Installation	308451
Gas Generator and Exhaust Installation	308452
Propellant Feed System Installation	407226
Electrical Equipment Installation	502101
Pneumatic System Installation	556351
Lube System Installation	556352
Loose Equipment List	651601

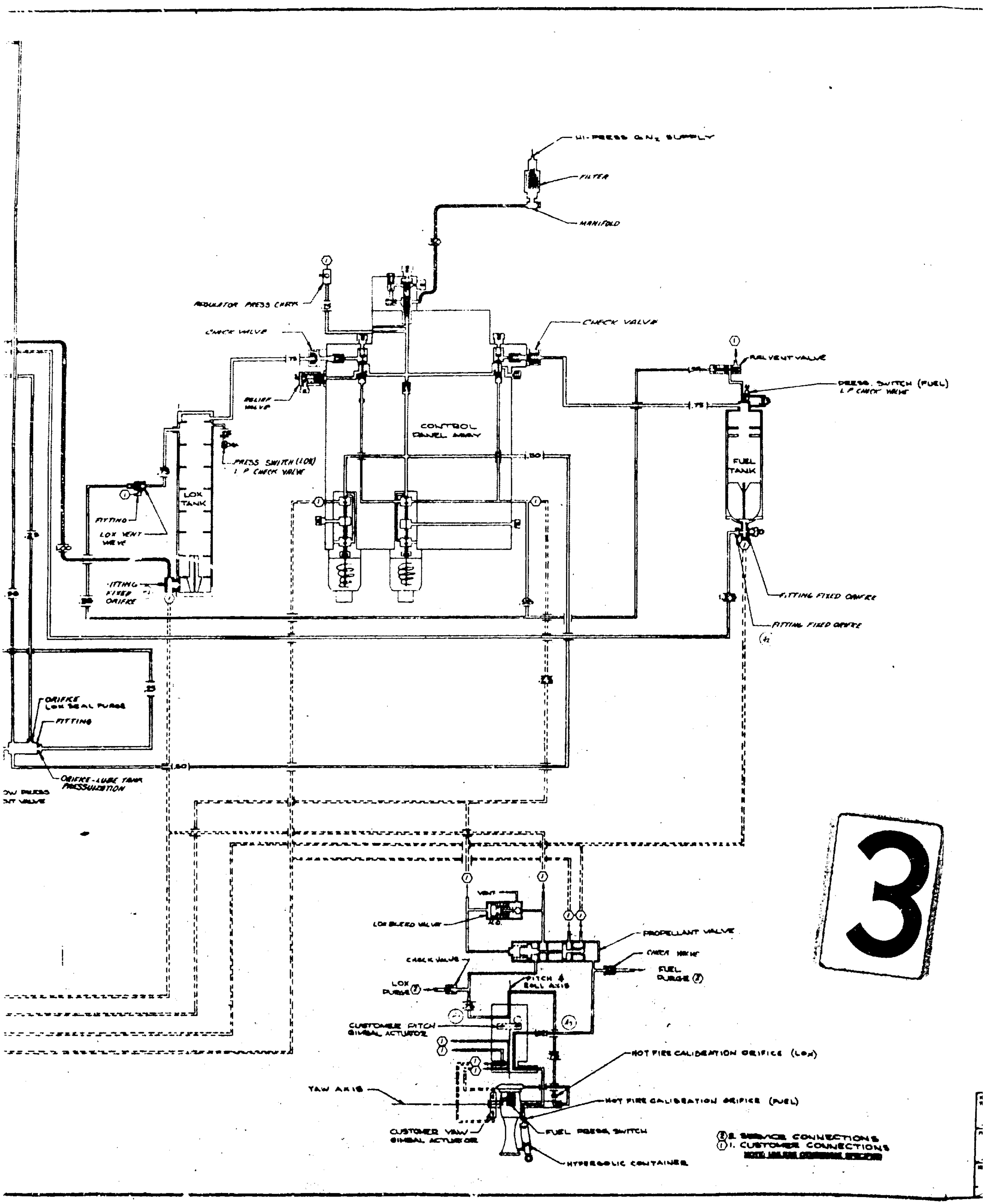
LR101-NA-11 Vernier Engine

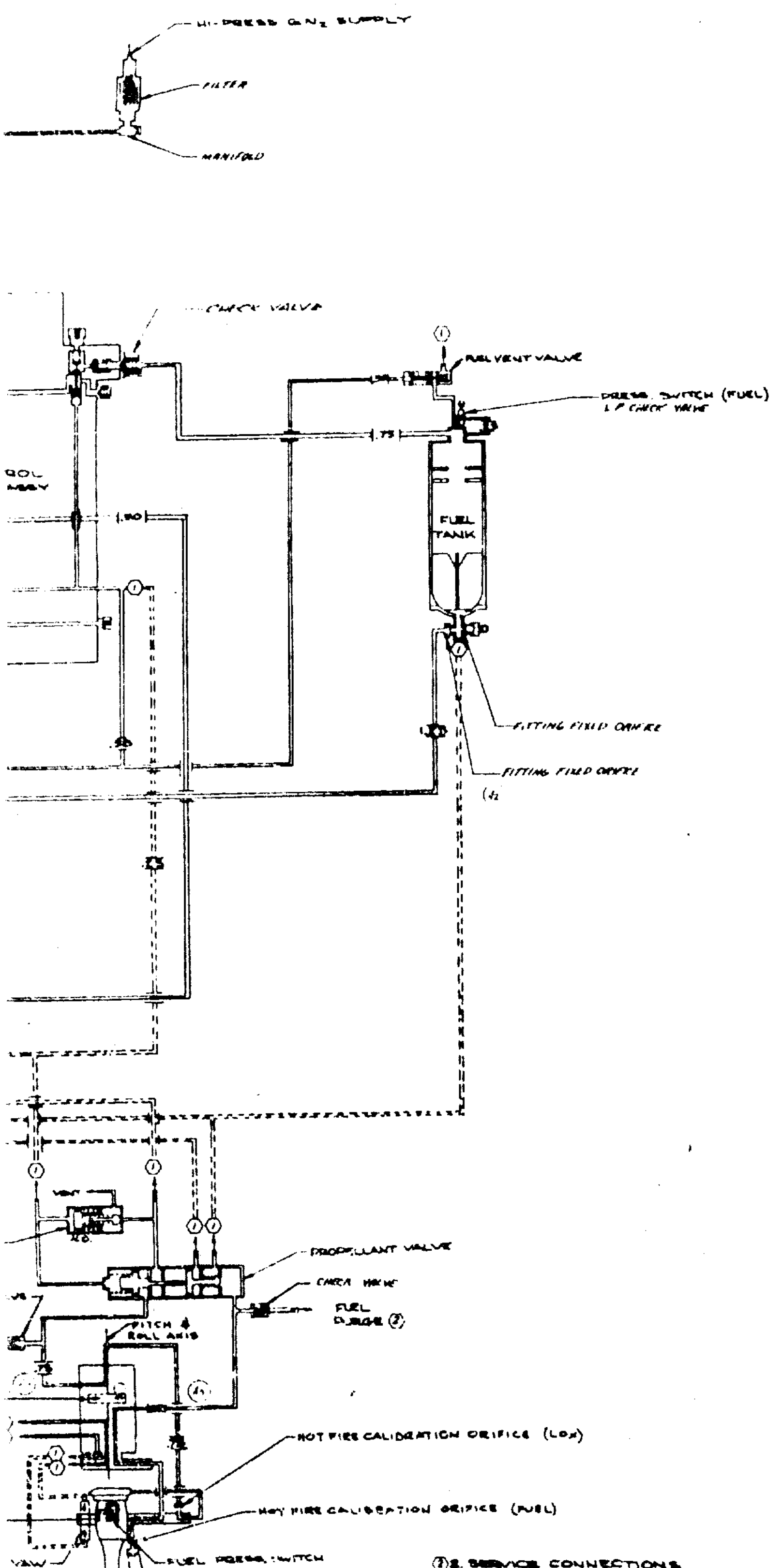
Engine Assembly Drawing	350655
Gimbal Body Installation	350660
Propellant Feed System Installation	350665
Orifice and Accessory Installation	350670
Loose Equipment List	350674
Electrical Installation	350675

1


PRESS VENT VALVE
SOLENOID VALVE
N.CL.
N.O
LOX INLET
DUCT
CHECK VALVE
HOSE ASSY
FITTING
FLOW RESTRICTOR VALVE
MAIN LOX VALVE
RESTRICTOR
IGN. VALVE
CHECK VALVE
HYPERGOLIC CONTAINER
IGNITER & PLUG ASSY
LOX BLEED VALVE
VENT
PROP VALVE
CHECK VALVE
CHECK VALVE
FUEL PURGE
LOX PURGE
PITCH & ROLL AXIS
YAW AXIS
CUSTOMER PITCH GIMBAL ACTUATOR
HOT FIRE CALIBRATION ORIFICE (LOX)
HOT FIRE CALIBRATION ORIFICE (FUEL)
FUEL PRESS SWITCH
HYPERGOLIC CONTAINER
CUSTOMER YAW GIMBAL ACTUATOR


CHECK VALVE
LUBE TANK
PRESSURIZING VALVE
FITTING
FLOW RESTRICTOR VALVE
FILTER
LUBE OIL PUMP
TURBOPUMP ASS'Y
GEAR CASE
DRAIN
MANIFOLD SCREEN
ORIFICE
CONTROL ORIFICE
FIXED ORIFICE
FUEL INLET
TURBINE
CHECK VALVE
GAS GENERATOR
HOSE ASSY
DUCT
ORIFICE
CHECK VALVE
G.G. CLOSE
CHECK VALVE
RESTRICTOR
GIMBAL
MAIN LOX VALVE
RESTRICTOR
FITTING, ORIFICE
FITTING
HE OUTLET
HEAT EXCHANGER
CHECK VALVE
MAIN FUEL VALVE
CHECK VALVE
LOX ELBOW
THRUST CHAMBER
HYDRAULIC CONTAINER
IGNITER & PLUG ASSY
CHECK VALVE FITTING & NOZZLE
SOLENOID VALVE
ORIFICE LOX SEAL PURGE
FITTING
ORIFICE-LUBE TANK PRESSURIZATION
LOW PRESS VENT VALVE
2


HI-PRESS GN2 SUPPLY
FILTER
MANIFOLD
REGULATOR PRESS CHECK
CHECK VALVE
CHECK VALVE
RELIEF VALVE
FUEL VENT VALVE
PRESS. SWITCH (FUEL)
L.P. CHECK VALVE
CONTROL PANEL ASSY
PRESS SWITCH (LOX)
L.P. CHECK VALVE
LOX TANK
FUEL TANK
FITTING
LOX VENT VALVE
FITTING FIXED ORIFICE
FITTING FIXED ORIFICE
FITTING FIXED ORIFICE
ORIFICE LOX SEAL PURGE
FITTING
ORIFICE-LUBE TANK PRESSURIZATION
LOX BLEED VALVE
VENT
PROPELLANT VALVE
CHECK VALVE
CHECK VALVE
FUEL PURGE
LOX PURGE
PITCH & ROLL AXIS
CUSTOMER PITCH GIMBAL ACTUATOR
HOT FIRE CALIBRATION ORIFICE (LOX)
HOT FIRE CALIBRATION ORIFICE (FUEL)
YAW AXIS
CUSTOMER YAW GIMBAL ACTUATOR
FUEL PRESS SWITCH
HYPERGOLIC CONTAINER
2. SERVICE CONNECTIONS
1. CUSTOMER CONNECTIONS
3



(2) 2. SERVICE CONNECTIONS
(1) 1. CUSTOMER CONNECTIONS
NOTE: UNLESS OTHERWISE SPECIFIED

REVISIONS

SYM	ZONE	DESCRIPTION		DATE	APPROVED
A		1 MAY BE REWORKED 3 RECORD CHANGE 2 CANNOT BE REWORKED 4 NOW SHOP PRACTICE 5 PARTS MADE ON			
	4,5	1 RELOCATED VARIABLE ORIFICE TO ZONE 5 FROM ZONE 4	3		
		2 REMOVED (FOR R&D FUEL ONLY)	3		
	4,6	3 REVISED NOMINAL ORIFICE (FUEL) & NOMINAL ORIFICE (LOX) LOCATIONS & RESTRICTOR	3		
	4,5	4 ADDED (1) HEAT EXCHANGER OUTLET, & ADAPTER TO FITTING FIXED ORIFICE			
	6	5 ADDED WORD "GIMBAL", "ORIFICE", & (1) TURBOPUMP DRAIN			

4

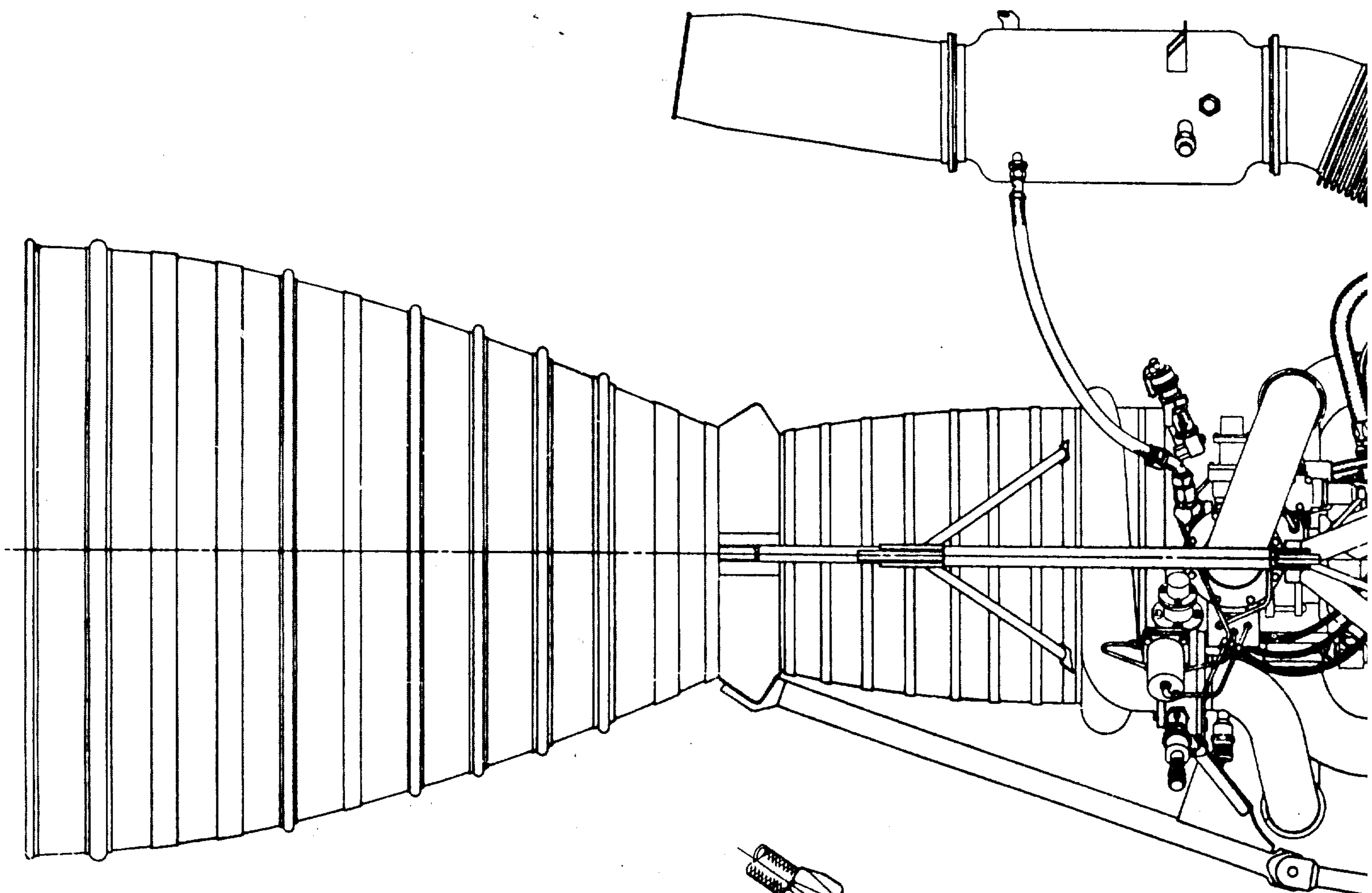
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND APPLY PRIOR TO FINISH
TOLERANCES ON DECIMALS ANGLES
DO NOT SCALE PRINT

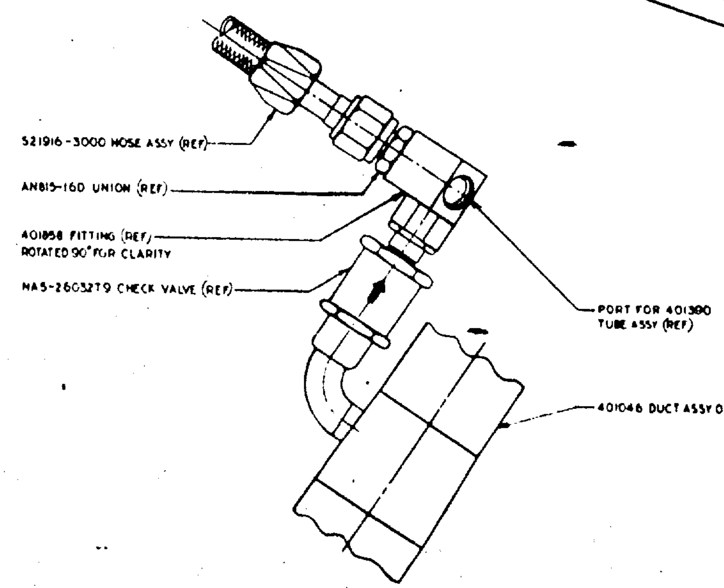
ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.
CANOGA PARK, CALIFORNIA

SCHEMATIC, ENGINE SYSTEM

CODE IDENT NO	SIZE	
02602	J	104655

SCALE

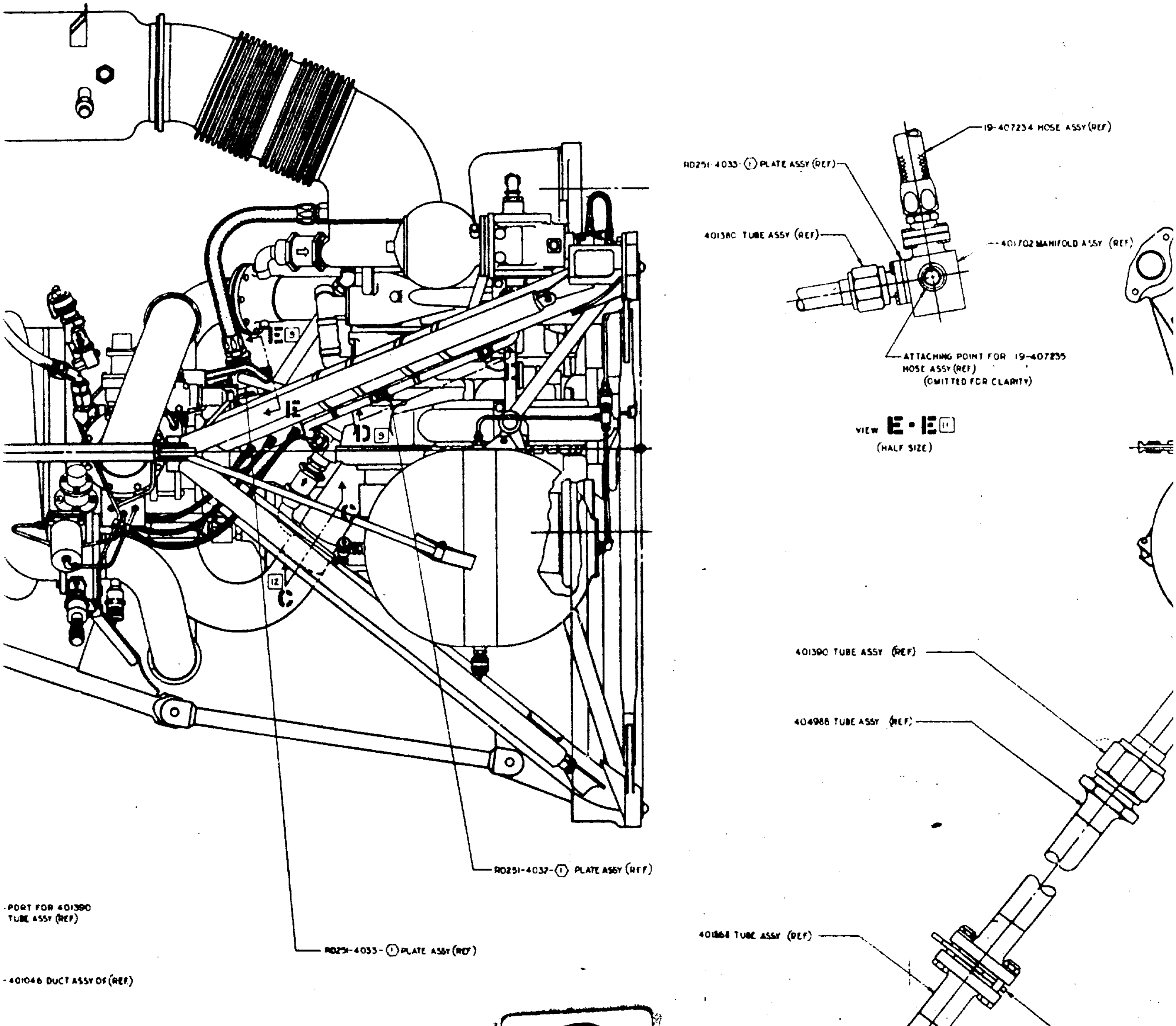




VIEW **C - C** 11
(HALF SIZE)

1

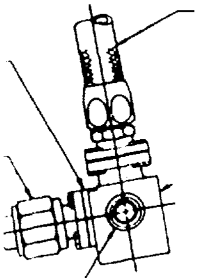
13 | 12 | 11



19-407234 HOSE ASSY (REF)
RD251-4033-(1) PLATE ASSY (REF)
401380 TUBE ASSY (REF)
401702 MANIFOLD ASSY (REF)
ATTACHING POINT FOR 19-407235 HOSE ASSY (REF) (OMITTED FOR CLARITY)
VIEW E-E 11
(HALF SIZE)
401390 TUBE ASSY (REF)
404988 TUBE ASSY (REF)
401868 TUBE ASSY (REF)
RD251-4032-(1) PL
VIEW D-D 10
(FULL SIZE)
RD251-4032-(1) PLATE ASSY (REF)
PORT FOR 401390 TUBE ASSY (REF)
RD251-4033-(1) PLATE ASSY (REF)
401046 DUCT ASSY OF (REF)

2

11	10	9



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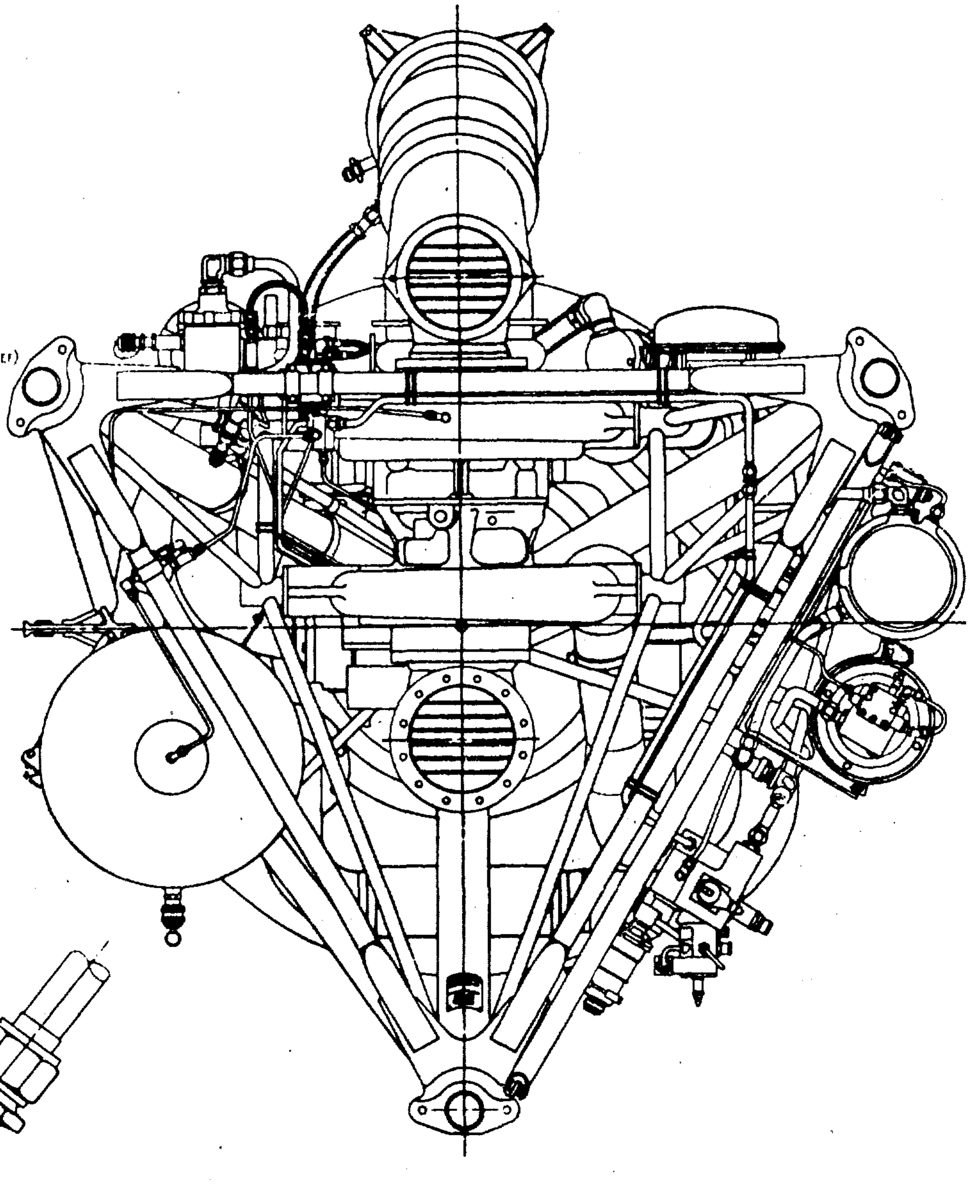

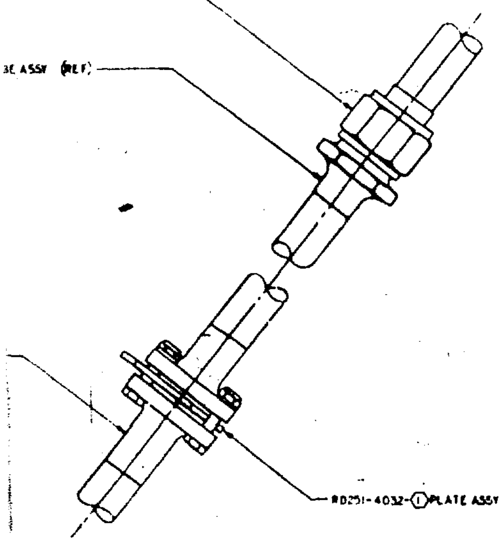

VIEW **D-D** 10
(FULL SIZE)

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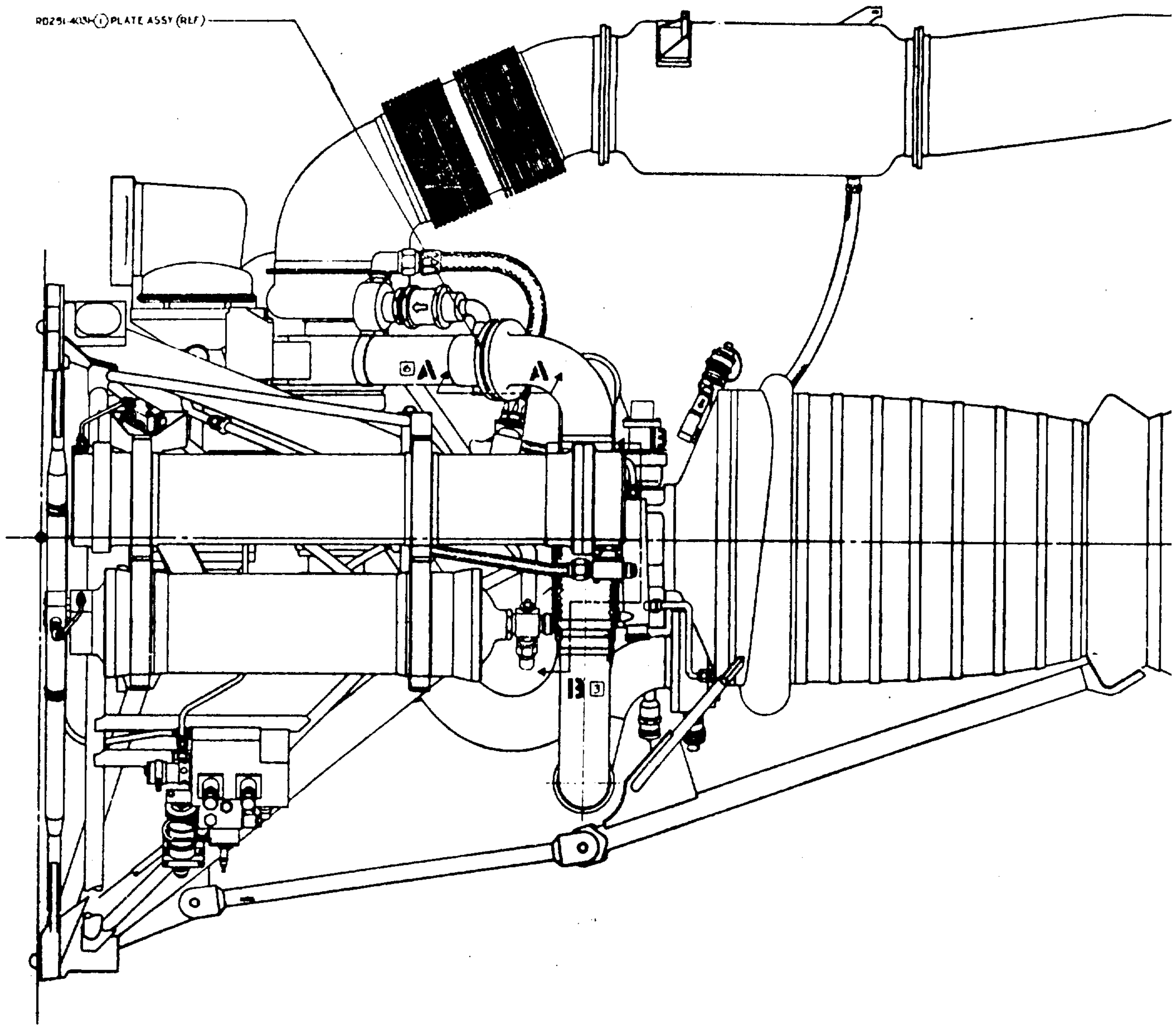

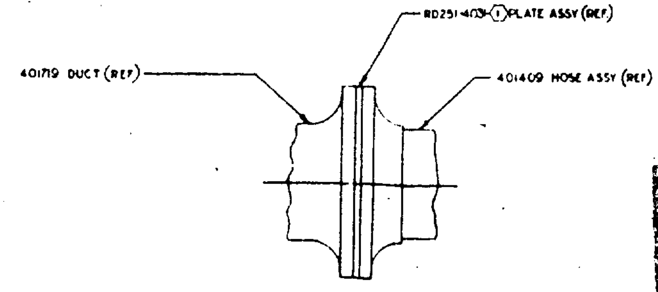

VIEW A-A 6
(HALF SIZE)

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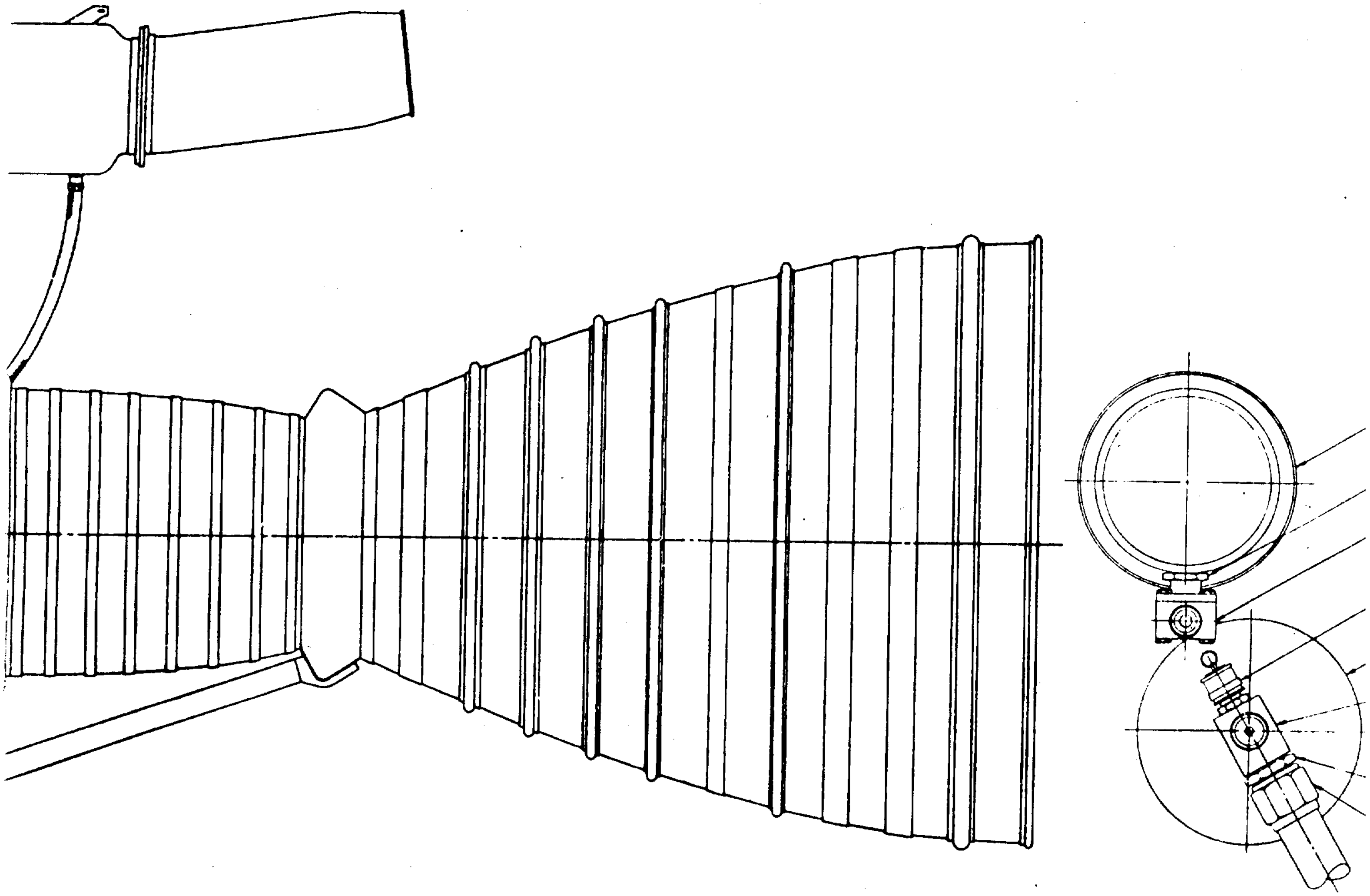

VIEW B-B 6
(HALF SIZE)

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REVISIONS

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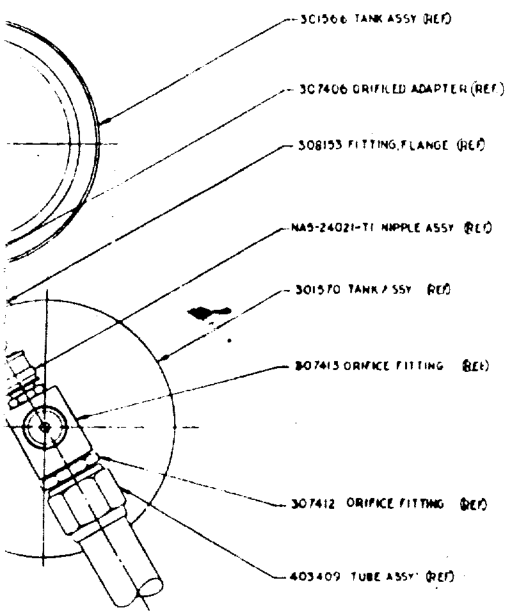


B-B 6
(HALF SIZE)

6

FOR REFERENCE ONLY

(1) 1. ORIFICE DIAMETER TO BE DETERMINED BY RA0201-109.
IDENTIFY ALTERED PARTS PER RA0104-010 TO REFLECT
THE ORIFICE DIAMETER

NOTE: UNLESS OTHERWISE SPECIFIED

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND APPLY PRIOR TO FINISH

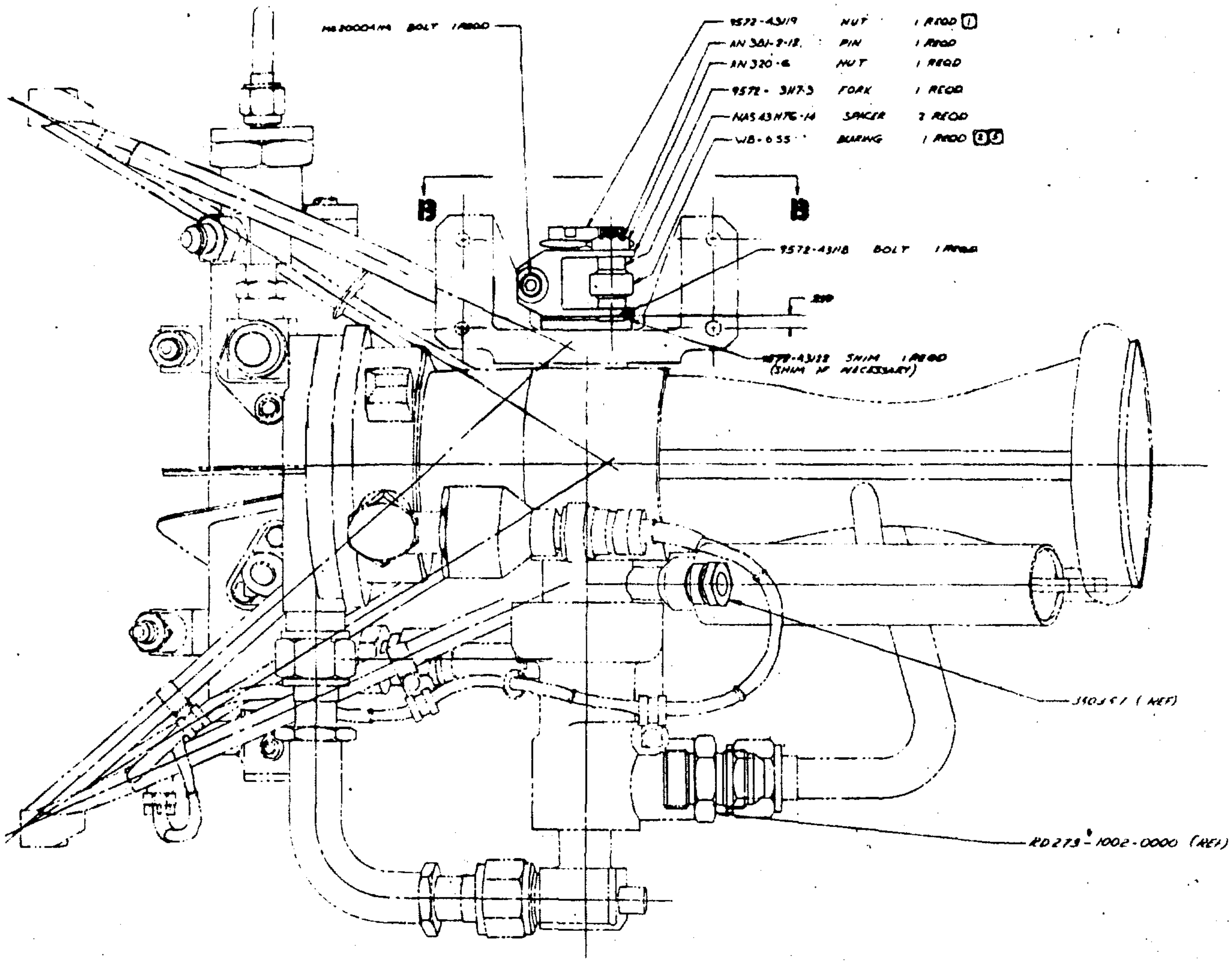
DO NOT SCALE PRINT

DR BY H SPANGLER 5-3-63

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC
CANOGA PARK, CALIFORNIA

ORIFICE
LOCATIONS

CODE IDENT NO.	SIZE	
02602	J	408113



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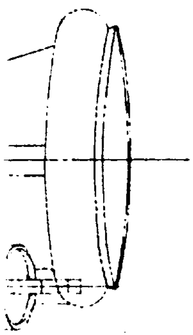
1

MAS-26301 SWITCH
MS29778-4 PACKING



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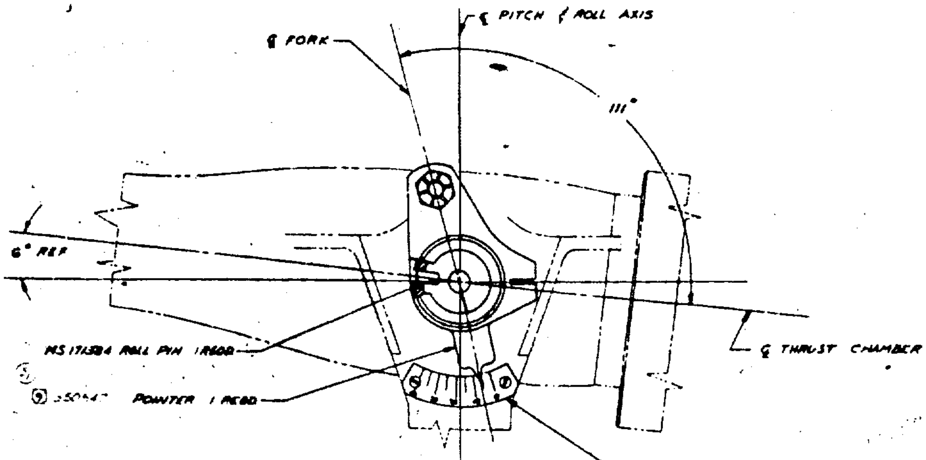
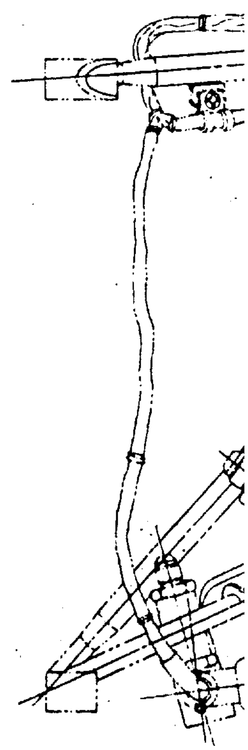
PD275-1002-0000 (REF)

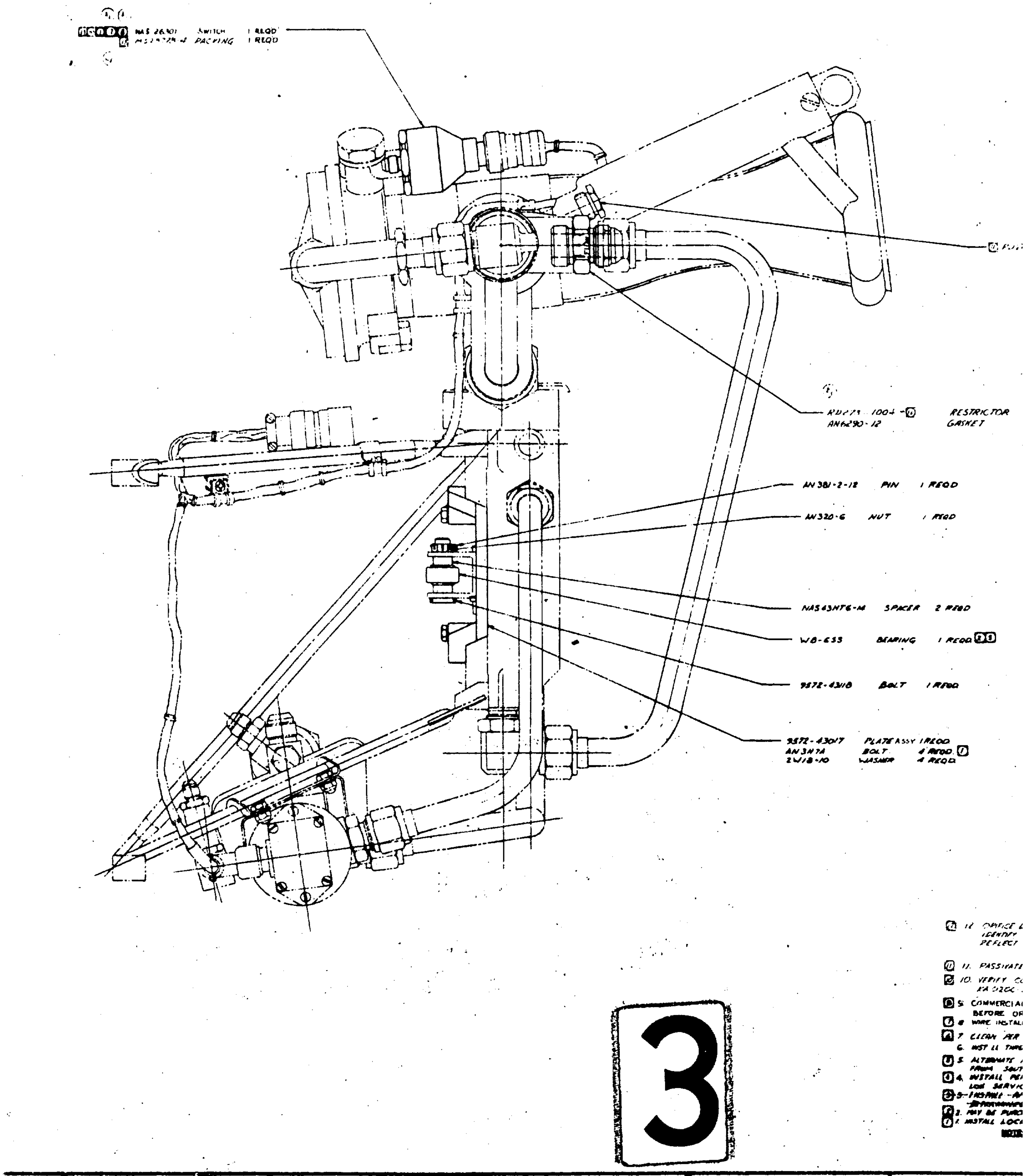


VIEW B B

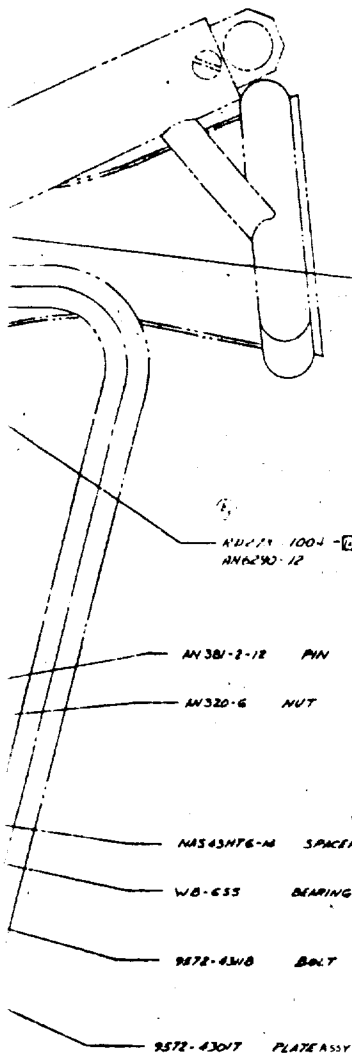


2

6 5



NAS 26301 SWITCH 1 REQD
PACKING 1 REQD
RESTRICTOR
AN6290-12 GASKET
AN381-2-12 PIN 1 REQD
AN320-6 NUT 1 REQD
NAS43HT6-14 SPACER 2 REQD
WB-6SS BEARING 1 REQD
9572-43118 BOLT 1 REQD
9572-43017 PLATE ASSY 1 REQD
AN3H7A BOLT 4 REQD
2W18-10 WASHER 4 REQD
11. PASSIVATE
10. VERIFY
8. COMMERCIAL
BEFORE
7. CLEAN PER
5. ALTERNATE
4. INSTALL
2. MAY BE
1. INSTALL
3
4



REVISIONS

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	2	IN G/N 4, RA0102-003 WAS FA6-20	3	
	3	ADDED G/N 8 & 9, 7 8	3	
	4	IN G/N 1, RA0101-002 WAS FA603 Z. EFFECT ON ITEM 1, ELRO1-NA-11 ENG 334801 & SUBS	5	
	B			
	1	9 350647 1 REQD WAS 350003 1 REQD & ADDED SERVICE NOTE. EFFECT ON ELRO1-NA-11 ...	5	ECP 90599
4	2	ADDED G/N 10 & CODE 10 TO NAS-26301 SWITCH. EFFECT ON ELRO1-NA-11 ENG 334934 & SUBS	1	ECP 90521
2	3	RD271-1007-12 1 REQD WAS 350857 1 REQD 9 & RD271-1004-12 1 REQD 6 WAS RD271-1002-0000 1 REQD 9 6	5	ECP 90512
2	4	ADDED G/N 11 & 12 & 11 12, DELETED G/N 3 & 3, ADDED 11 TO FINISH BLOCK. EFFECT ON ITEM 3 & 4 ELRO1-NA-11 REL 3306 & SUBS	5	ECP 90512
4	5	ADDED 4 7 6 8 NAS-272-4 SWITCH 1 REQD & ADDED EFFECT ON BLOCK. EFFECT ON ELRO1-NA-11 ENG 334935 & SUBS	1	ECP
	C			
4	1	REMOVED 4 7 6 8 NAS 272-4 SWITCH 1 REQD & 12 MS27... GASKET 1 REQD WAS AN6290-4 1 REQD & IN EFFECT ON BLOCK	5	3-24-61
2		REMOVED 4 334935 & SUBS. EFFECT ON ELRO1-NA-11 ENG 334935 & SUBS		

1 334801	334934	ELRO1-NA-11
ENG	THRU	MODEL
EFFECTIVE ON		

9 350647 SUPERSEDES 350003 FOR FUTURE PROCUREMENT

12 12. ORIFICE DIA TO BE DETERMINED BY RA0201-032. IDENTIFY ALTERED PARTS PER RA0104-010 TO REFLECT THE ORIFICE DIA

11 11. PASSIVATE PER RA0110-015

10 10. VERIFY COMPLIANCE WITH SPECIFICATION RA0200-082 PRIOR TO INSTALLATION

9 9. COMMERCIAL PART, SEE NAS SPEC BEFORE ORDERING

7 8. WIRE INSTALLATION PER RA0113-001

6 7. CLEAN PER RA0110-004 (LOX SERVICE)

6. INSTALL THREADED FASTENERS PER RA0101-002

5 5. ALTERNATE PART NO BADR-6720, MAY BE PURCHASED FROM SOUTHWEST PRODUCTS CO. DUARTE, CALIF.

4 4. INSTALL PER RA0112-002 & LUBRICATE PER RA0112-002 FOR LOX SERVICE, STATIC

3 ~~3. INSTALL AFTER I.D. HAS BEEN MACHINED TO DIA DETERMINED BY CALIBRATION TESTS.~~

2 2. MAY BE PURCHASED FROM STEWART-ADAMSON MFG, AURORA, ILL.

1 1. INSTALL LOCKWIRE PER RA0101-002

NOTE: UNLESS OTHERWISE SPECIFIED

4

ORIFICE & ACCESSORY INSTALLATION - VERNIER ENGINE

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.
6633 CANOGA AVE. CANOGA PARK, CALIFORNIA

SCALE FULL

J 350670

2 1

CUSTOMER CONNECT INFORMATION

This portion of the report contains information related to LV-2A propulsion system installation, weight distribution, instrumentation, electrical requirements, and general operating requirements and limitations.

ALLOWABLE INSTALLATION MISALIGNMENTS

The coordinate system used by Rocketdyne for designating reference axes and their origins is given in Fig. 2 . Data are intended for use in the orientation of the LV-2A propulsion system in the Thor missile boattail.

Table 2 lists the customer connect points, coordinates the expected flight deflections of each point, and the allowable installation misalignments of the LOX and fuel pump inlet bellows for the main engine. The recommended maximum installation misalignment is based upon an inlet bellows approximately 13.5 inches long with an axial spring rate of 600 lb/in. and a maximum lateral spring rate of 500 lb/in. The recommendations assume that:

1. The bellows spring rates will be verified by laboratory test.
2. No liners are present in the bellows unless tests prove that there is a possibility of the liners "bottoming" or "hanging up" when subjected to maximum deflections resulting from the sum of allowable installation misalignment and turbopump and missile deflections.

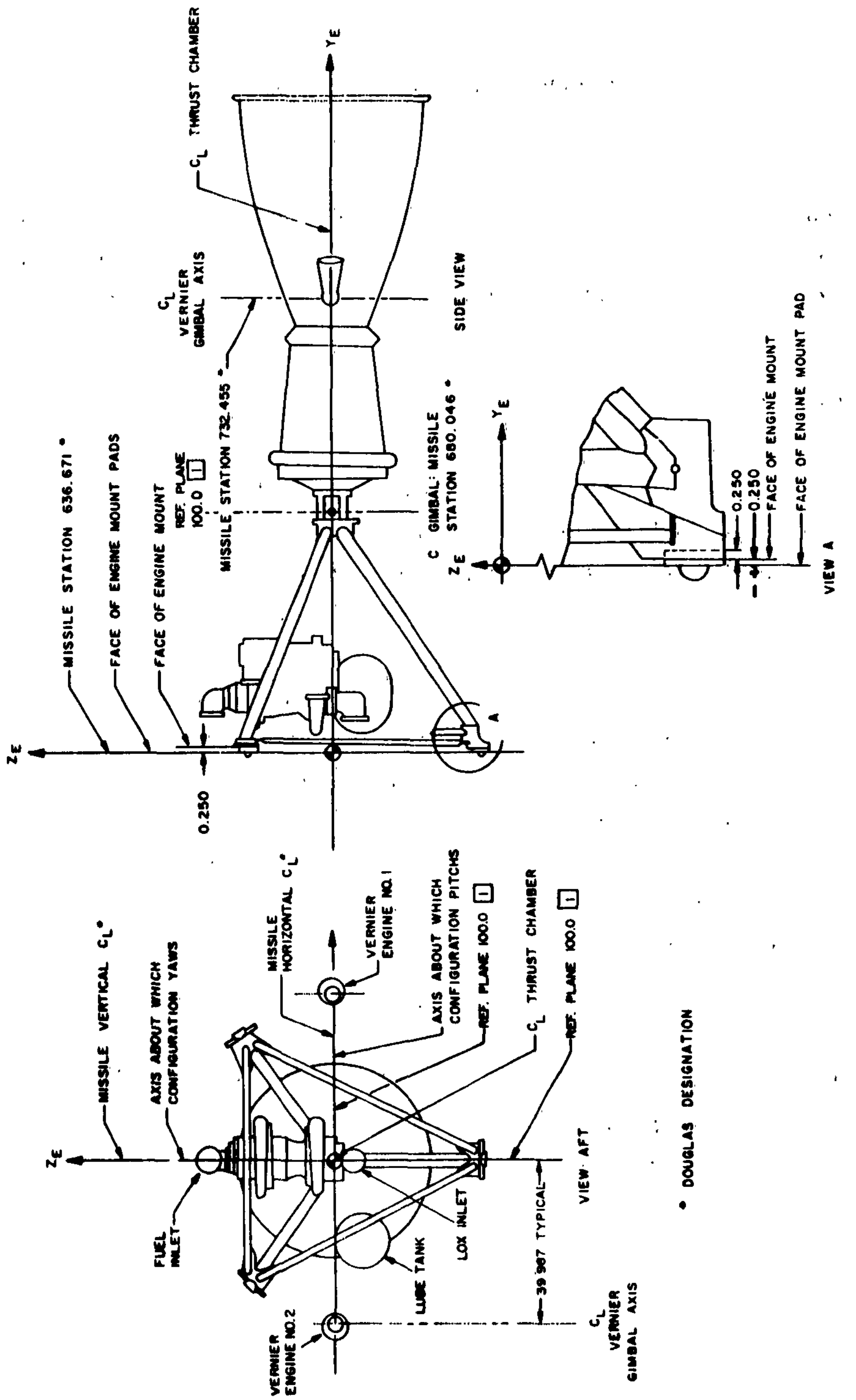


Figure 2. Coordinate System

1

TABLE 2

LV-2A PROPULSI

DEFLECTIONS AND ALLOWABLE INS

Customer Connect Points	Coordinates, inches (Drawing No. 104654)			Approximate Flight Deflection	
	X	Y	Z	ΔX	ΔY
Geometrical center of triangle formed by the three thrust missile attach points.	0.000	0.000	0.000		
Mount Attach to Missile	28.919	0.000	16.697	The three thrust mount-to-mis will deflect radially (outboa	
Mount Attach to Missile	-28.919	0.000	16.697		
Mount Attach to Missile	0.000	0.000	-33.393		
Turbopump, LOX Inlet Elbow	0.000 ±0.187	6.500 ±0.132	-7.776 ±0.187	±0.12	+0.12 to -0.37
Turbopump, Fuel Inlet Elbow	0.000 ±0.187	5.250 ±0.132	23.963 ±0.187	±0.12	+0.31 to -0.12
Forward Pitch Actuator Attach Point (Center of Bearing)	0.000 ±0.12	12.407 ±0.12	-28.703 ±0.12		
Aft Pitch Actuator Attach Point (Center of Bearing)	0.000 ±0.37	43.375 ±0.37	-24.000 ±0.34		
Forward Yaw Actuator Attach Point (Center of Bearing)	-24.000 ±0.34	43.375 ±0.12	0.000 ±0.12	Deflections of actuator attach	
Aft Yaw Actuator Attach Point (Center of Bearing)	-28.703 ±0.12	74.341 ±0.12	0.000 ±0.12		
Forward Attach Lug, Heat Exchanger	6.12 ±0.12	51.27 ±0.12	40.69 ±0.12	The three heat exchanger attac enclosed by these lugs must no closed by the three thrust att	
Forward Attach Lug, Heat Exchanger	6.12 ±0.12	51.27 ±0.12	40.69 ±0.12		
Aft Attach Lug, Heat Exchanger (Center of Slot)	0.00 ±0.12	66.25 ±0.12	41.32 ±0.12		

*Refer to note 1 on drawing 104654. The total transverse misalignment shall not exceed (

TABLE 2

LV-2A PROPULSION SYSTEM

: AND ALLOWABLE INSTALLATION MISALIGNMENTS

e Flight Deflections, inches		Allowable Installation Misalignment With Respect To Engine, inches					
ΔY	ΔZ	ΔX	ΔY	ΔZ	θX	θY	θZ
thrust mount-to-missile attach points are within 0.010 inch of true position. The attach points :t radially (outboard) 0.044 ±0.010 (NA-13) inch during flight.							
+0.12 to -0.37	+0.25 to -0.12	±0.50*	0.50 Tension or Compression	±0.50	±3*	0	±3
+0.31 to -0.12	+0.25 to -0.12	±0.50*	0.75 ± 0.50 Tension	±0.50	±3*	0	±3
of actuator attach points do not affect the missile structure,							
eat exchanger attach lugs are mated with the missile. The centroid of the triangular area these lugs must not deflect more than 0.37 inch relative to the centroid of the area en- he three thrust attach points.							

shall not exceed 0.50 inch.

2

1

TABLE 2
(Continued)

Customer Connect Points	Coordinates, inches (Drawing No. 104654)			Approximate Flight Deflections, i		
	X	Y	Z	ΔX	ΔY	ΔZ
Oxygen Outlet, Heat Exchanger	-7.93 ±0.12	51.37 ±0.12	30.87 ±0.12	Deflects with missile		
Aft End Heat Exchanger	0.00 ±0.12	69.43 ±0.12*	34.57 ±0.12	Deflects with missile		
LOX Supply to Vernier Engine	30.63 ±0.12	47.07 +0.34 −0.27	−2.48 +0.47 −0.49	±0.12	+0.31 to −0.12	±0.
Fuel Supply to Vernier Engines	28.15 +0.29 −0.31	40.85 +0.27 −0.28	−6.82 +0.33 −0.31	±0.12	+0.25 to −0.12	±0.
Main Oil Discharge	1.33 ±0.12	29.73 ±0.12	14.72 ±0.12	±0.12	+0.19 to −0.12	±0.
Fuel Start Tank Vent Valve Vent	20.19 ±0.12	12.53 ±0.12	−0.18 ±0.12	±0.12	+0.25 to −0.12	±0.
LOX Start Tank Vent Valve Vent	24.70 ±0.12	6.54 ±0.12	−14.06 ±0.12	±0.12	+0.19 to −0.12	±0.1
High-Pressure Gaseous Nitrogen Supply	8.65 ±0.12	11.35 ±0.12	−26.45 ±0.12	±0.12	+0.19 to −0.12	±0.1
Center Tachometer Mount Pad (No gasket)	−0.40 ±0.12	20.07 ±0.12	−3.76 ±0.12	±0.25	+0.12 to −0.25	±0.2
Center Hydraulic Pump Mount Pad (No gasket)	3.96 ±0.12	24.85 ±0.12	−1.26 ±0.12	±0.25	+0.12 to −0.25	±0.2
LOX Seal Drain	−2.00 ±0.12	30.17 ±0.12	15.98 ±0.12	±0.25	+0.19 to −0.12	±0.3
Oil Seal Drain	−3.50 ±0.12	29.90 ±0.12	15.87 ±0.12	±0.12	+0.25 to −0.12	±0.3
Pressure Takeoff from Pneumatic Manifold	15.08 ±0.12	7.40 ±0.12	−15.17 ±0.12	±0.12	+0.19 to −0.12	±0.1

*Refer to note 7 on drawing 104654

FORM R 18-G-18

TABLE 2

(Continued)

...mate Flight Deflections, inches			Allowable Installation Misalignment With Respect to Engine, inches					
	ΔY	ΔZ	ΔX	ΔY	ΔZ	θX	θY	θZ
...s with missile			The customer connect points are to be connected with no load applied except that necessary to support its weight. The parts shall be designed and installed to provide for both maximum missile and maximum flight deflections.					
...s with missile								
	+0.31 to −0.12	±0.12	Turbine Exhaust System (a) The aft flange of the turbine exhaust duct assembly shall be parallel with the heat exchanger flange within four degrees. (b) The distance between the two flanges shall be 0.31 ±0.25 inch (c) The misalignment of the centerline of the two flanges shall not exceed 0.38 inch					
	+0.25 to −0.12	±0.12						
	+0.19 to −0.12	±0.37						
	+0.25 to −0.12	±0.12						
	+0.19 to −0.12	±0.12						
	+0.19 to −0.12	±0.12						
	+0.12 to −0.25	±0.25						
	+0.12 to −0.25	±0.25						
	+0.19 to −0.12	±0.37						
	+0.25 to −0.12	±0.37						
	+0.19 to −0.12	±0.12						

2

TABLE
(Contin

Customer Connect Points	Coordinates, inches (Drawing No. 104654)			Approximate Flight Deflecti	
	X	Y	Z	ΔX	ΔY
Electrical Ground Connection	17.25*	11.40	17.48	±0.19	+0.25 to -0.12
Missile Interconnection	17.25	14.05	17.55	±0.19	+0.25 to -0.12
Missile Power Connection	19.35*	13.25	17.55	±0.19	+0.25 to -0.12
Vernier LOX Vent Valve Control Solenoid Exit	14.33 ±0.12	21.18 ±0.12	-3.41 ±0.12	±0.12	+0.19 to -0.12
Vernier Engine Propellant Valve Control Solenoid Exit	15.92 ±0.12	23.31 ±0.12	-4.33 ±0.12	±0.12	+0.19 to -0.12
Lube Tank Vent and Overflow	-19.23 ±0.12	2.59 ±0.12	5.27 ±0.12	±0.06	±0.06
Lube Tank Horizontal Drain					

*Refer to note 9 on drawing 104654

1

FORM R 18-G-18

TABLE 2
(Continued)

ate Flight Deflections, inches		Allowable Installation Misalignment With Respect to Engine, inches					
ΔY	ΔZ	ΔX	ΔY	ΔZ	θX	θY	θZ
+0.25 to −0.12	±0.19	These values are based on inlet bellows which have an axial inlet bellows with an axial spring rate of 600 lb/in. and a maximum transverse spring rate of 500 lb/in.					
+0.25 to −0.12	±0.19						
+0.25 to −0.12	±0.19						
+0.19 to −0.12	±0.12						
+0.19 to −0.12	±0.12						
±0.06	±0.06						

WEIGHT DISTRIBUTION AND FLUID VOLUMES

Weight, balance, inertia, and fluid volume information for the LV-2A propulsion system configurations is presented in Tables 3 and 4.

This data may be used in determining missile deadweight distribution, structural requirements, basic loads, stability, performance, and control requirements.

CUSTOMER CONNECT AND INSTRUMENTATION DRAWINGS

The locations of connections that are necessary for the operation of the LV-2A propulsion system in the missile are shown in Drawings 104654 and 350723. Locations shown include those for supply connections, drain and vent connections, and flush and purge connections. Structural attachments and accessory pad information are shown, as well as gimbal bearing alignment and lubrication points.

The instrumentation tap locations on the main vernier engines that are available for use appear in Drawings 702827 and 350050.

TABLE 3

CENTER OF GRAVITY, MOMENT OF INERTIA, AND WEIGHTS
FOR MAIN ENGINE (RJ-1 FUEL)

Propulsion system weights and centers of gravity* (including vernier engines)

Condition	Weight, pounds	Y Arm, inches	X Arm, inches	Z Arm, inches
Dry	2116	100.2	100.4	103.3
Wet	2690	100.0	100.6	102.3
Burnout	2468	101.5	100.5	102.8

*Reference point (gimbal bearing) is (100,100,100).

Moments of inertia of the propulsion system about axes through its center of gravity, wet and dry, with corresponding radii of gyration

Condition	Weight, pounds	Y Roll	X Pitch	Z Yaw
Dry	2116	167 slug sq ft	616 slug sq ft	626 slug sq ft
Radii of gyration		19.1 inches	36.7 inches	37.0 inches
Wet	2690	223 slug sq ft	782 slug sq ft	816 slug sq ft
Radii of gyration		19.6 inches	36.7 inches	37.5 inches

Moment of inertia of the gimballed mass about the gimbal axes (verniers not included)

Condition	Weight, pounds	Y Roll, slug sq ft	X Pitch, slug sq ft
Dry	828	32	311
Wet	1057	44	416

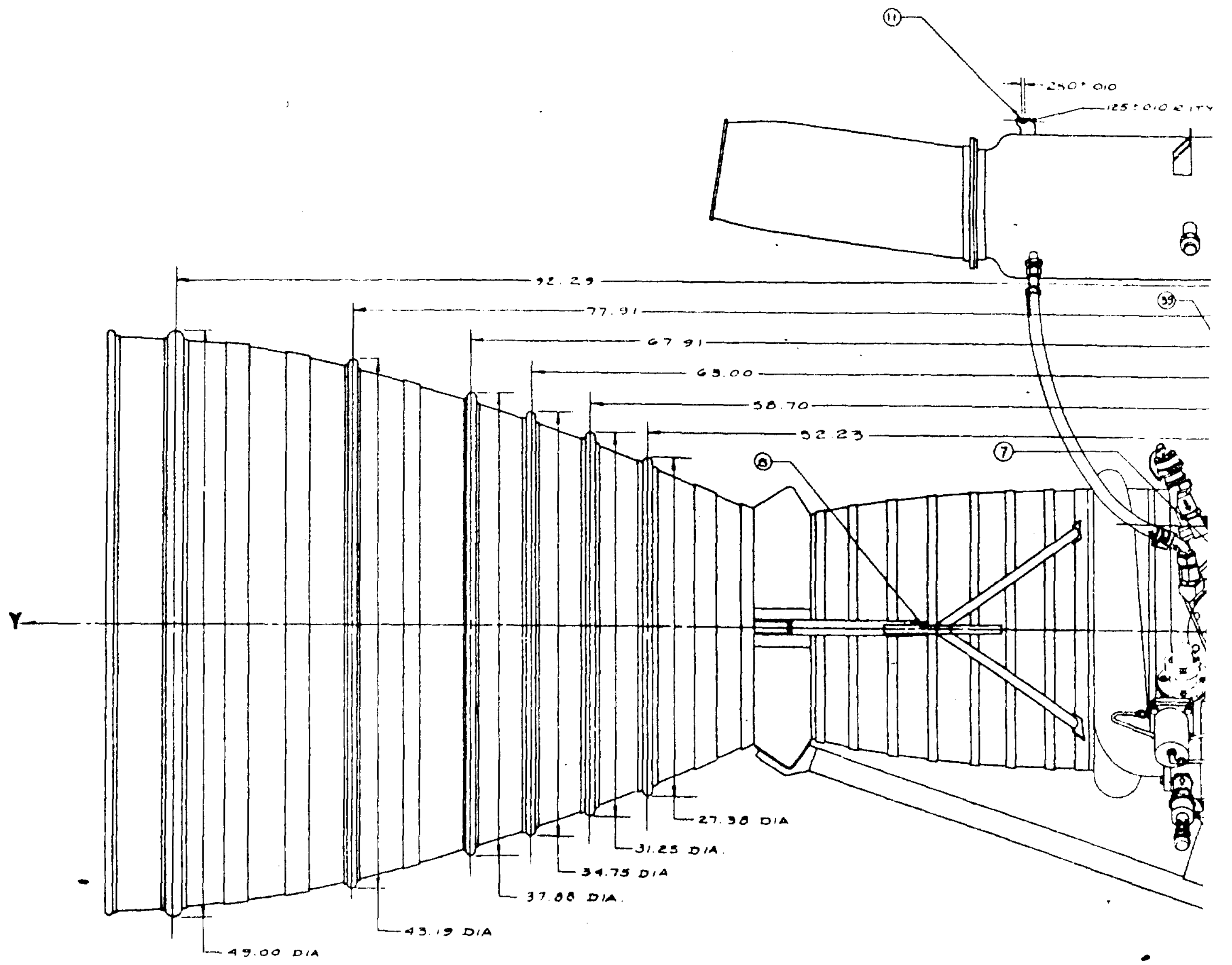
Longitudinal (Y axis) location of center of gravity of the gimballed mass in inches aft of the gimbal axis.

Dry = 29.0 inches
Wet = 29.2 inches

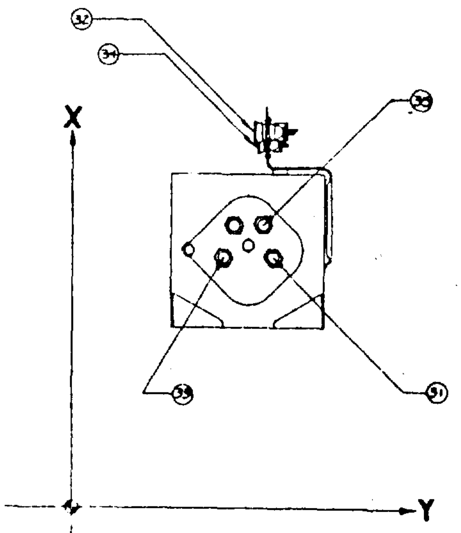
TABLE 4

MAIN ENGINE FLUID VOLUME DATA

Component	Fuel Volume, cu in.	Liquid Oxygen Volume, cu in.	Oil Volume, cu in.
Thrust Chamber	3987	935	
Main Ducts	1111	1614	
Turbopump	950	945	
Lubrication System			3927
Start System	1319	1454	
Vernier Engines (2)	106	46	
Miscellaneous Units	120	183	



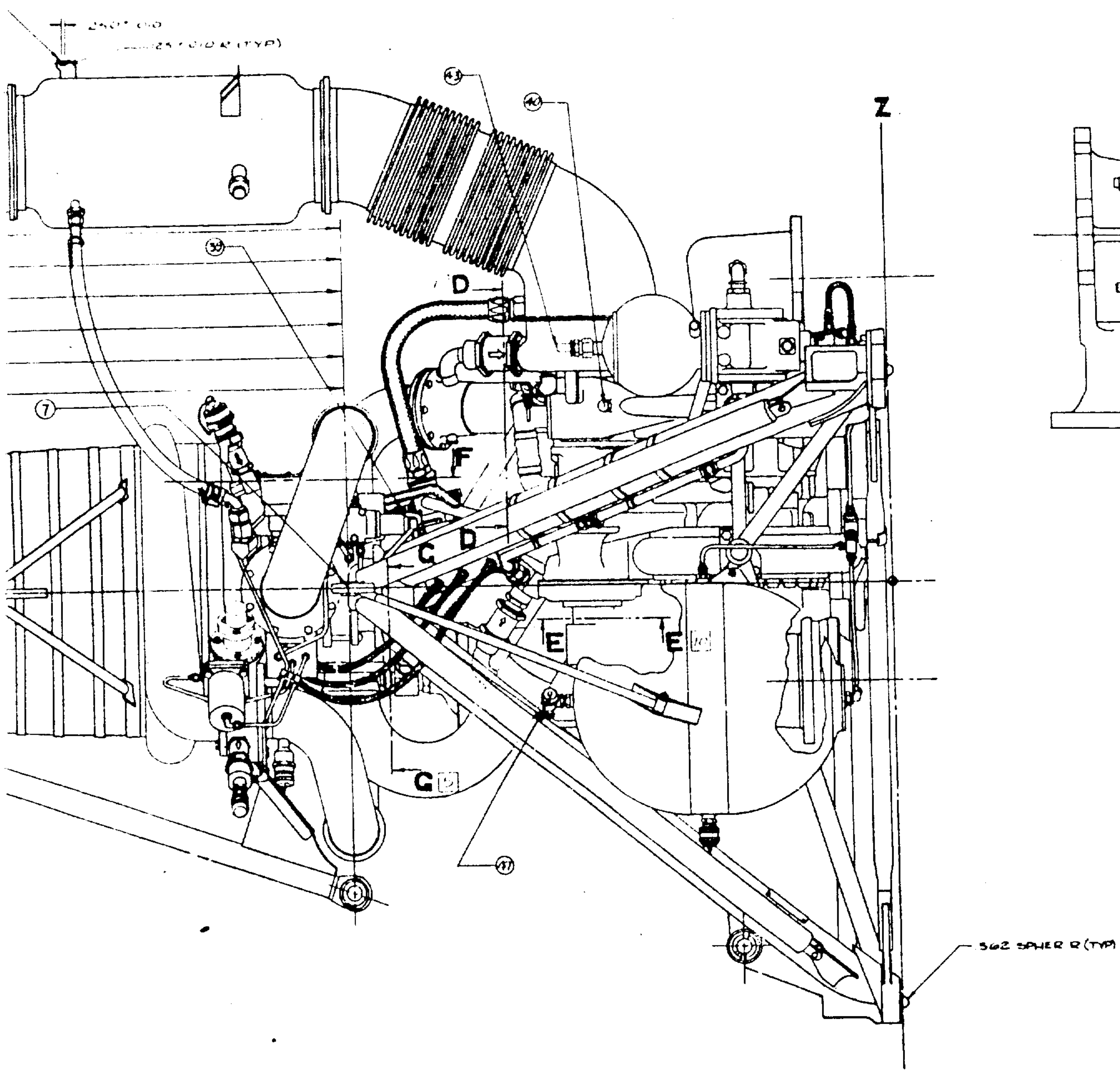
.250±.010
.125±.010
92.29
77.91
67.91
63.00
58.70
52.23
Y
27.38 DIA
31.25 DIA.
34.75 DIA
37.88 DIA.
43.19 DIA
49.00 DIA

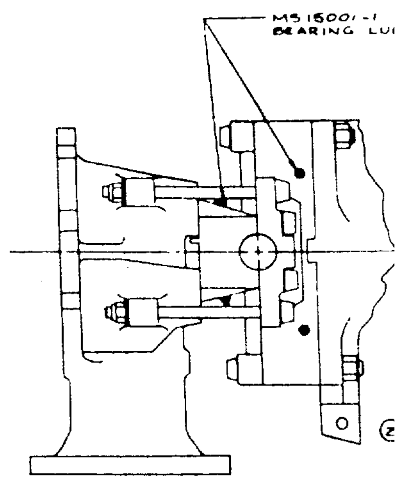


X
Y

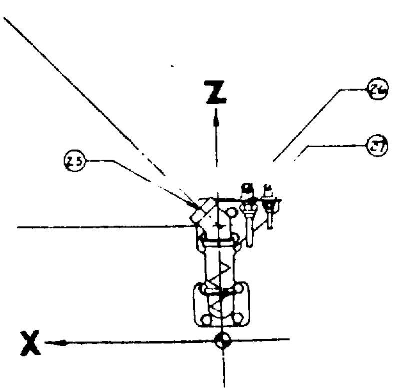
VIEW A-A 7

1



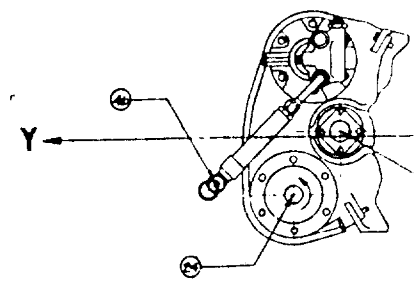


VIEW **F-F**
SCALE 1/2

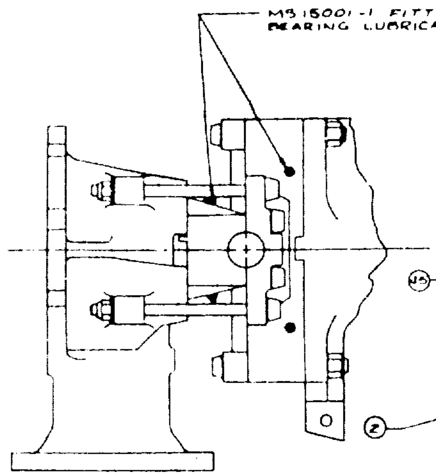


VIEW **D-D**

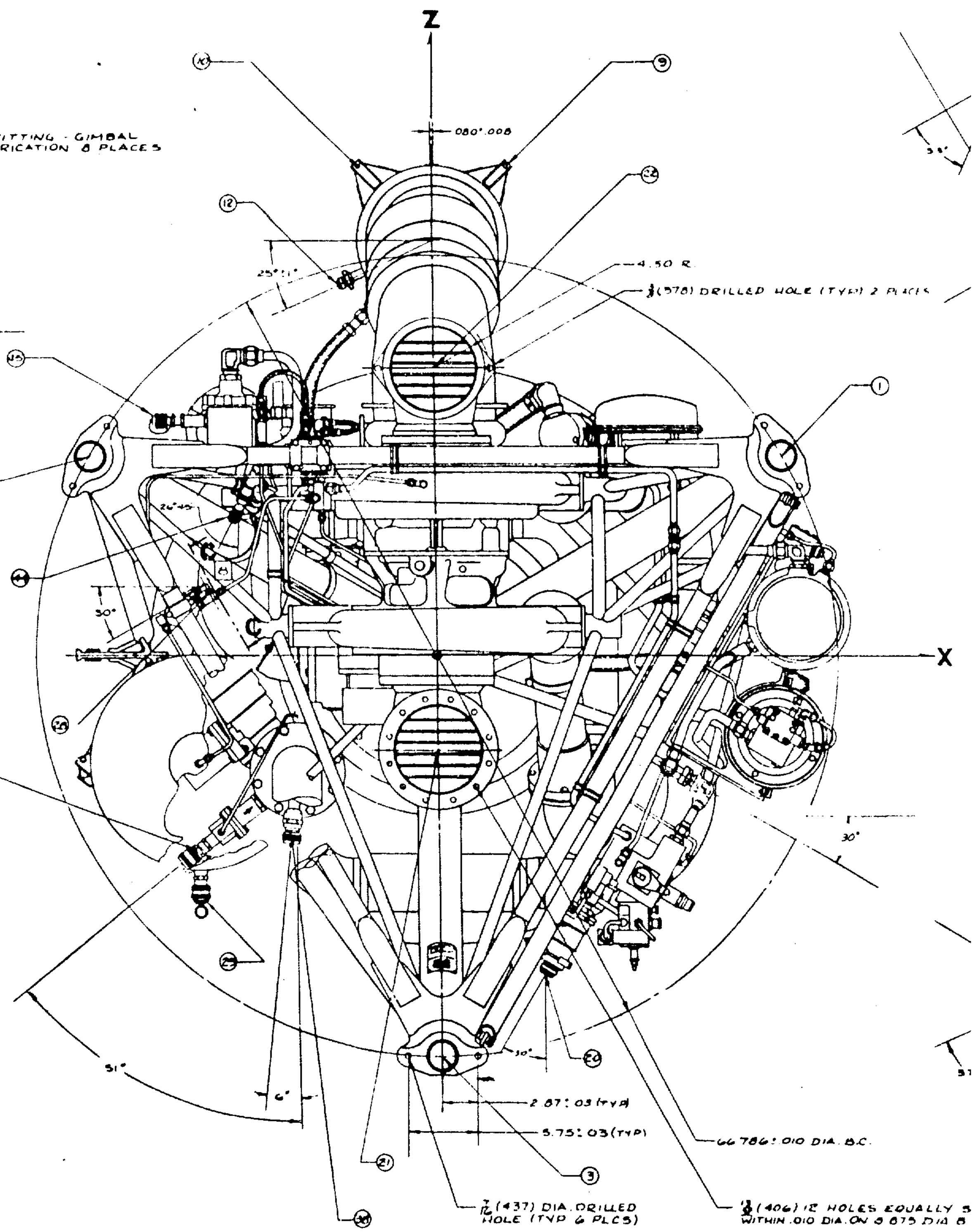
2



VIEW **E-E**



VIEW **F-F**
SCALE 1/2



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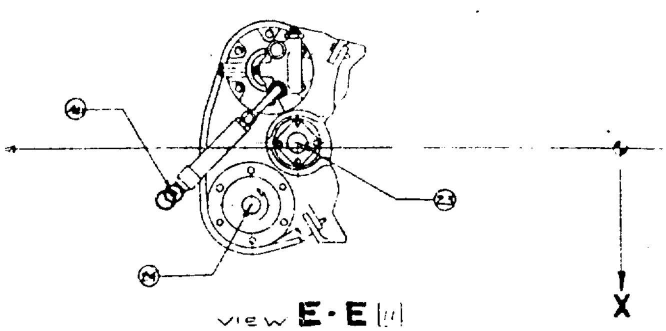
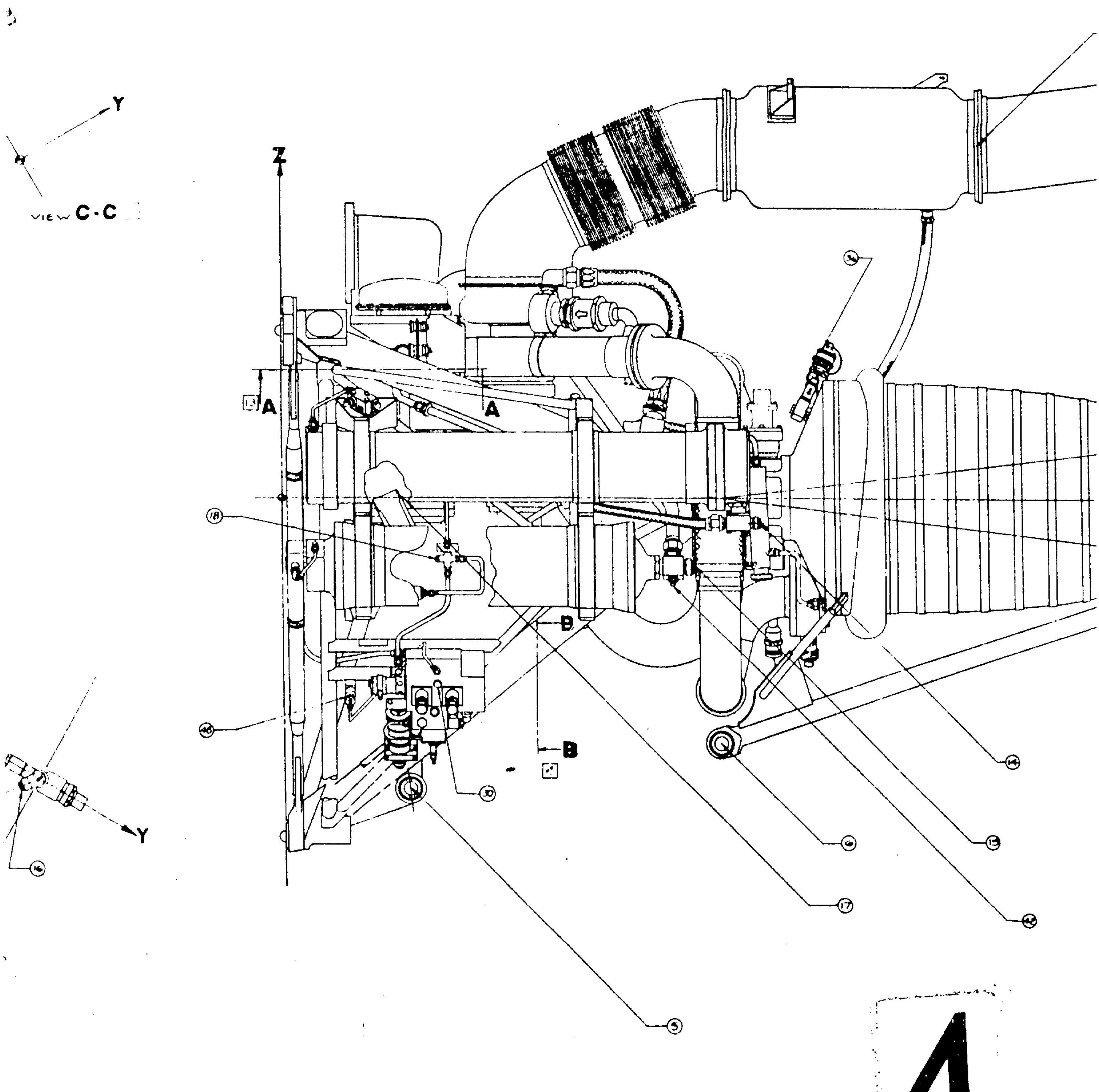


VIEW **E-E**

3



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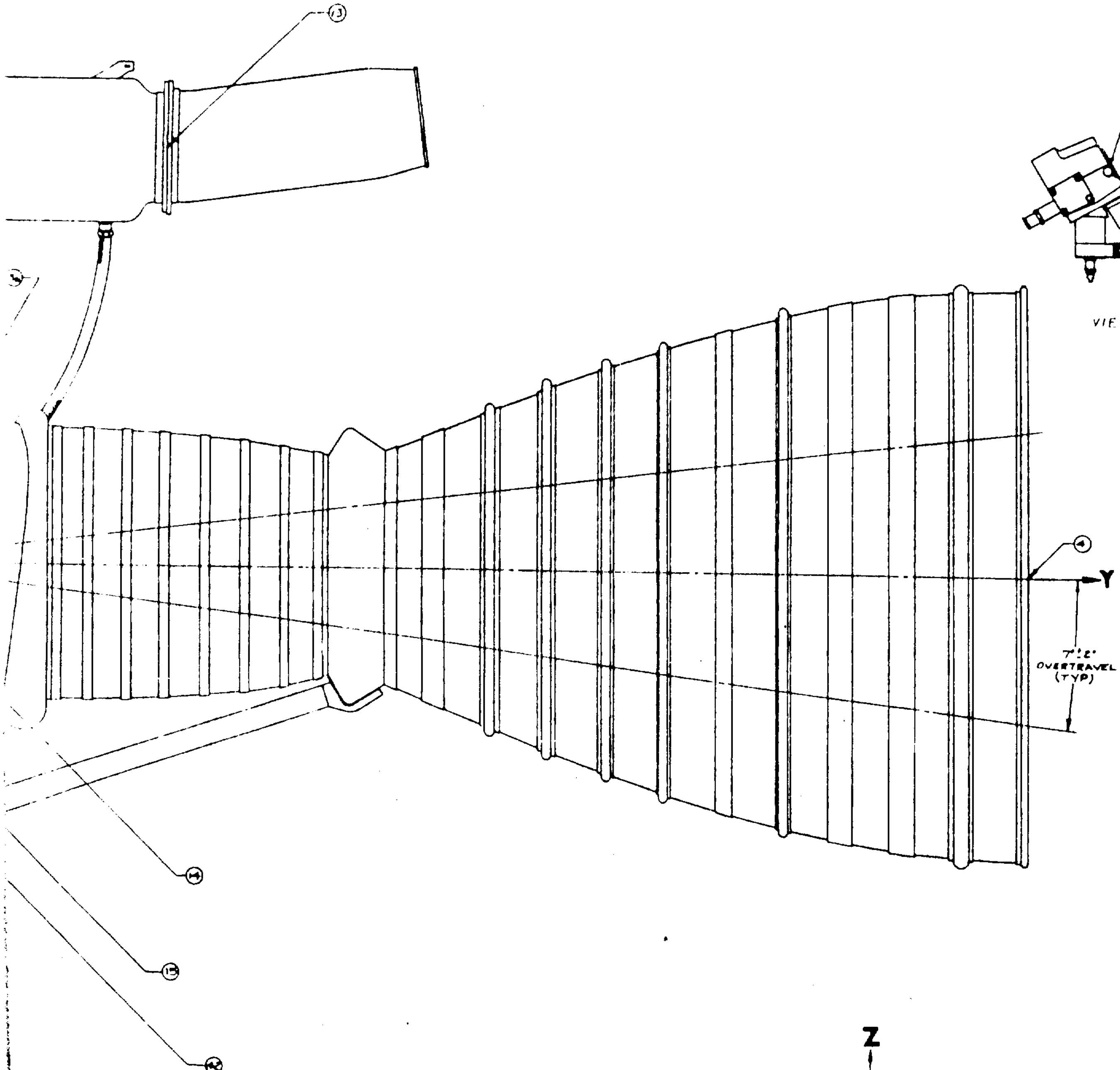
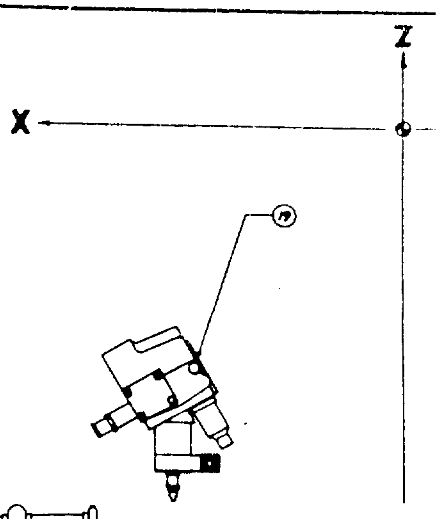
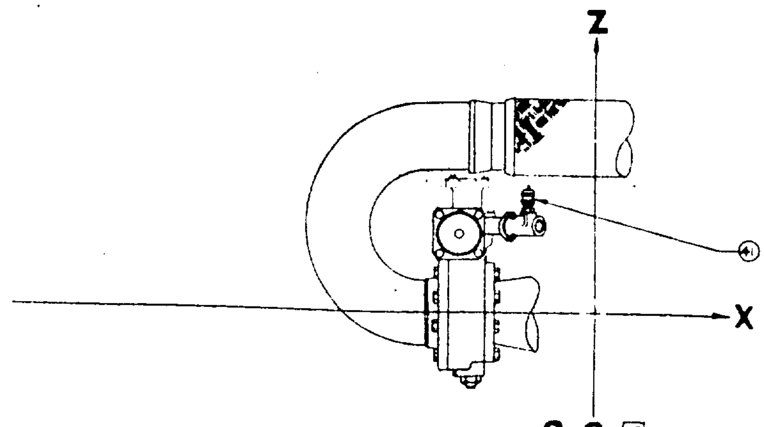




VIEW B-B [7]

POINT	TYPE OF CONN	ZONE	DIS X
1	(1)	8	+20.9
2	(1)	10	-28.9
3	(1)	9	0.00
4		4	0.0
5	(1)	6	0.0
6	(1)	6	0.00
7	(1)	12	-24.0
8	(1)	14	-20.70
9	(1)	9	+ 6.12
10	(1)	10	- 6.12
11	(1)	12	0.00
12	(1)	9	- 7.9
13		6	0.0
14	(1)	5	+30.7
15	(1)	6	+28.15
16		8	+31.38
17		6	+30.19
18	(1)	4	+20.31
19	(1)	4	+14.26
20		9	+ 8.6
21	(1)	9	0.00
22	(1)	9	0.00
23	(1)	10	- 0.4
24	(1)	10	+ 3.9
25	(1)	12	+ 1.3
26	(1)	11	- 2.0
27	(1)	11	- 3.5
28	(1)	10	- 19.2
29	(2)	9	
30	(1)	9	+1917
31	(1)	13	+17.2
32	(1)	13	
33	(1)	13	+17.2
34	(1)	13	
35	(1)	13	+19.3
36	(2)	6	
37	(2)	10	
38	(2)	9	
39	(2)	12	
40	(2)	11	
41	(2)	4	
42	(2)	6	
43	(2)	12	
44	(2)	10	
45	(2)	10	
46	(2)	10	
47	(2)	11	
48	(2)	7	
49			
50			



VIEW C-C [12]

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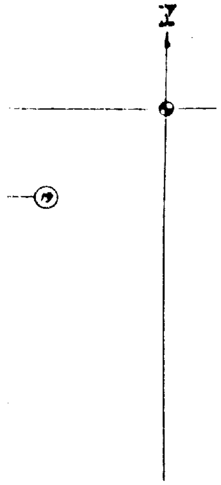


B-B (7)

POINT	TYPE OF CONN	ZONE	DISTANCES FROM ORIGIN X	Y	Z	DESCRIPTION	END OF CONNECTION
1	(1)	8	+28.919	0.000	+16.697	MOUNT ATTACH TO MISSILE	
2	(1)	10	-28.919	0.000	+16.697	MOUNT ATTACH TO MISSILE	
3	(1)	9	0.000	0.000	35.393	MOUNT ATTACH TO MISSILE	
4		4	0.000	+141.56	0.000	END OF THRUST CHAMBER	46.025.00
(5) 5	(1)	6	0.000	+18.407	20.703	FWD PITCH ACTUATOR ATTACH POINT CENTER OF BEARING	BEARING B00R14155 (1)
(5) 6	(1)	6	0.000	+43.375	-24.000	AFT PITCH ACTUATOR ATTACH POINT CENTER OF BEARING	BEARING B00R14155 (1)
(5) 7	(1)	12	-24.000	+43.375	0.000	FWD YAW ACTUATOR ATTACH POINT CENTER OF BEARING	BEARING B00R14155 (1)
(5) 8	(1)	14	-20.703	+74.941	0.000	AFT YAW ACTUATOR ATTACH POINT CENTER OF BEARING	BEARING B00R14155 (1)
9	(1)	9	+6.12	+51.27	+40.69	FWD ATTACH LUG-HEAT EXCHANGER	℄ DRILLED HOLE
10	(1)	10	-6.12	+51.27	+40.69	FWD ATTACH LUG-HEAT EXCHANGER	℄ DRILLED HOLE
11	(1)	12	0.00	+[illegible]25	41.32	AFT ATTACH LUG-HEAT EXCHANGER CENTER OF HOLE	
12	(1)	9	-7.93	+51.37	-30.87	OXYGEN OUTLET-HEAT EXCHANGER	PER MS33656-16
13		6	0.00	+69.43	+34.57	AFT END HEAT EXCHANGER	
14		[illegible]	+30.72	+[illegible]	26.[illegible]	[illegible] VERNIER ENGINES	[illegible]
15		6	+28.15	+40.85	+8.2	FUEL SUPPLY TO VERNIER ENGINES	PER MS33656-20
16		8	+31.38	[illegible]	[illegible]	LIQ OXY START TANK VENT VALVE VENT	PER MS33656-12
17		6	+30.19	+12.55	-0.18	FUEL START TANK VENT VALVE VENT	PER MS33656-6
18		4	+20.91	+14.56	-6.30	VERNIER TOT VENT VALVE CONTROL SOLENOID VALVE	PER MS33656-4
19		4	+14.26	+18.32	-16.81	VERNIER ENGINE PROPELLANT VALVE CONTROL SOLENOID ASSY	PER AND10050-16
20		9	+[illegible]	+11.35	-26.45	HIGH PRESSURE GN2 SUPPLY	PER MS33656-16
21	(1)	9	0.000	+6.500	7.776	TURBOPUMP-LOX INLET ELBOW	
22		9	0.000	+5.250	+23.963	TURBOPUMP-FUEL INLET ELBOW	
23	(1)	10	-0.40	+22.07	-3.76	CENTER TACHOMETER MT PAD (NO GASKET)	PER AND20005
24	(1)	10	+3.96	+24.85	-1.26	CENTER HYD PUMP MT PAD (NO GASKET)	PER AND20002
25		12	+1.33	+29.73	+14.72	MAIN OIL DISCHARGE	PER AND10050-16
26		11	-2.00	+30.17	+15.90	LIQ OXY SEAL DRAIN	PER MS33656-8
27		11	-3.50	+29.90	+5.87	OIL SEAL DRAIN	PER MS33656-6
28		10	-19.23	+2.59	+5.27	LUBE TANK VENT & OVERFLOW	PER MS33656-4
29	(2)	9				LUBE TANK HORIZONTAL DRAIN	8005N67V8 NIPPLE ASSY (4)
30	(1)	9	+18.17	+15.13	-18.37	PRESS TAKEOFF FROM PNEU MANI.	PER AND10050-4
31	(1)	13	+17.25 (8)	14.05 (8)	+17.40 (8)	ELECTRICAL GROUND CONNECTION	500709-61
32	(1)	13	(8)	(8)	(8)	ELECTRICAL GROUND CONNECTION	MS3102E36-7P (7)
33	(1)	13	+17.25 (8)	11.40 (8)	17.55 (8)	MISSILE INTERCONNECTION	500709-81
34	(1)	13	(8)	(8)	(8)	MISSILE INTERCONNECTION	MS3102E20-27S (7)
35	(1)	13	+19.35 (8)	+13.25 (8)	17.55 (8)	MISSILE POWER CONNECTION	500709
36	(2)	6				LIQ OXY DOME PURGE	N32512 (4)
37	(2)	10				HYPERGOLIC FUEL MANIFOLD PURGE (FLUSH)	40100S N6 V12 (4)
38	(2)	9				FEED SYSTEM FUEL DRAIN	7005N65V12 (4)
39	(2)	12				BOOTSTRAP FUEL DRAIN	7005N65V4 (4)
40	(2)	11				TURBOPUMP FUEL VOLUTE DRAIN	7005N65V4 (4)
41	(2)	4				IGNITER VALVE FUEL DRAIN	7005N65V4 (4)
42	(2)	6				FUEL START TANK DRAIN	7005N65V4 (4)
43	(2)	12				GAS GENERATOR FUEL DRAIN	7005N65V4 (4)
44	(2)	10				GAS GENERATOR LIQ. OXY PURGE	592-54 (9)
45	(2)	10				GAS GENERATOR FUEL PURGE	592-55 (9)
46	(2)	10				TURBOPUMP GEARBOX FLUSH	8005N67V8 (4)
47	(2)	11				LUBE TANK FILL & FLUSH	8005N67V8 (4)
48	(2)	7				REGULATED PNEUMATIC PRESSURE TEST	NAS-24010
49							
50							

6

(9) 12 THE BRUNING CO, LINCOLN, NEBRASKA
(8) 11 THESE DIM'S NOT TO BE HELD TO ±.12 TOLERANCE
(7) 10 BENDIX AVIATION CORP SCINTILLA DIV, SIDNEY, N.Y.
(6) 9 CHANGE OF DIM. WITH FULL TANK -.20 (MAX)
8 SYMBOL ⊕ DENOTES ORIGIN OF REFERENCE SYSTEM-POSITIVE DIRECTIONS FROM ORIGIN ARE INDICATED BY ARROWHEADS ON AXES
(5) 7 FOR ALIGNMENT TOLERANCES REFER TO 9578-940004
6 TOLERANCES ±.12 FOR DIMENSIONED CUSTOMER CONNECTIONS
5 EFFECTIVE ON YLR 79-NA 13 ENGINES
(4) 4 E.B. WIGGINS OIL TOOL CO., LOS ANGELES 23, CALIF
(3) 3 SOUTHWEST PRODUCTS CO., DUARTE, CALIF
(2) 2 SERVICE CONNECTION
(1) 1 CUSTOMER CONNECTION TO MISSILE

NOTE: UNLESS OTHERWISE SPECIFIED

HEAT TREAT

FINISH

MAT'L

REVISIONS

SYM	ZONE	DESCRIPTION	DATE	APPROVED
		1 MAY BE REWORKED 3 RECORD CHANGE 2 CANNOT BE REWORKED 4 NOW SHOP PRACTICE 5 PARTS MADE OK		

ON	END OF CONNECTION
MISSILE	
MISSILE	
MISSILE	
AMBER	.46 O.2E O.D
[illegible]	BEARING BOSRI4155 (1)
[illegible] POINT	BEARING BOSRI4155 (1)
[illegible] POINT	BEARING BOSRI4155 (1)
ACH POINT	BEARING BOSRI4155 (1)
EXCHANGER	[illegible] DRILLED HOLE
EXCHANGER	[illegible] DRILLED HOLE
CHANGER	PER MS33656-16
CHANGER	
[illegible]	PER MS33656-16
IER ENGINES	PER MS33656-20
ALVE VENT	PER MS33656-12
ALVE VENT	PER MS33656-6
[illegible] VALVE	PER MS33656-4
	PER AND10050-6
SUPPLY	PER MS33656-16
T ELBOW	
T ELBOW	
[illegible](NO GASKET)	PER AND20005
D (NO GASKET)	PER AND20002
E	PER AND10050-16
N	PER MS33656-8
N	PER MS33656-6
OVERFLOW	PER MS33656-4
NTAL DRAIN	8005N67V8 NIPPLE ASSY (4)
EU MANI.	PER AND10050-4
ONNECTION	500709-61
ONNECTION	MS3102E36-7P (7)
ECTION	500709-51
ECTION	MS3102E20-27S (7)
VECTION	500709
RGE	N32512
D PURGE (FLUSH)	451005N66V12 (4)
RAIN	7005N65V12 (4)
DRAIN	7005N65V4 (4)
UTE DRAIN	7005N65V4 (4)
L DRAIN	7005N65V4 (4)
DRAIN	7005N65V4 (4)
DRAIN	7005N65V4 (4)
XY. PURGE	592-54 (9)
PURGE	592-55 (9)
X FLUSH	8005N67V8 (4)
FLUSH	8005N67V8 (4)
SSURE TEST	NAS.24010

7

(9) 12 THE BRUNING CO, LINCOLN, NEBRASKA
(3) 11 THESE DIM'S NOT TO BE HELD TO ±.12 TOLERANCE
(7) 10 BENDIX AVIATION CORP SCINTILLA DIV., SIDNEY, N Y
(2) 9 CHANGE OF DIM. WITH FULL TANK — .20 (MAX)
8 SYMBOL ⊕ DENOTES ORIGIN OF REFERENCE SYSTEM- POSITIVE DIRECTIONS FROM ORIGIN ARE INDICATED BY ARROWHEADS ON AXES
(5) 7 FOR ALIGNMENT TOLERANCES REFER TO 9572-940004
6 TOLERANCES ±.12 FOR DIMENSIONED CUSTOMER CONNECTIONS
5 EFFECTIVE ON YLR 79-NA-13 ENGINES
(4) 4 E B WIGGINS OIL TOOL CO., LOS ANGELES 23, CALIF
(3) 3 SOUTHWEST PRODUCTS CO., DUARTE, CALIF
(2) 2 SERVICE CONNECTION
(1) 1 CUSTOMER CONNECTION TO MISSILE

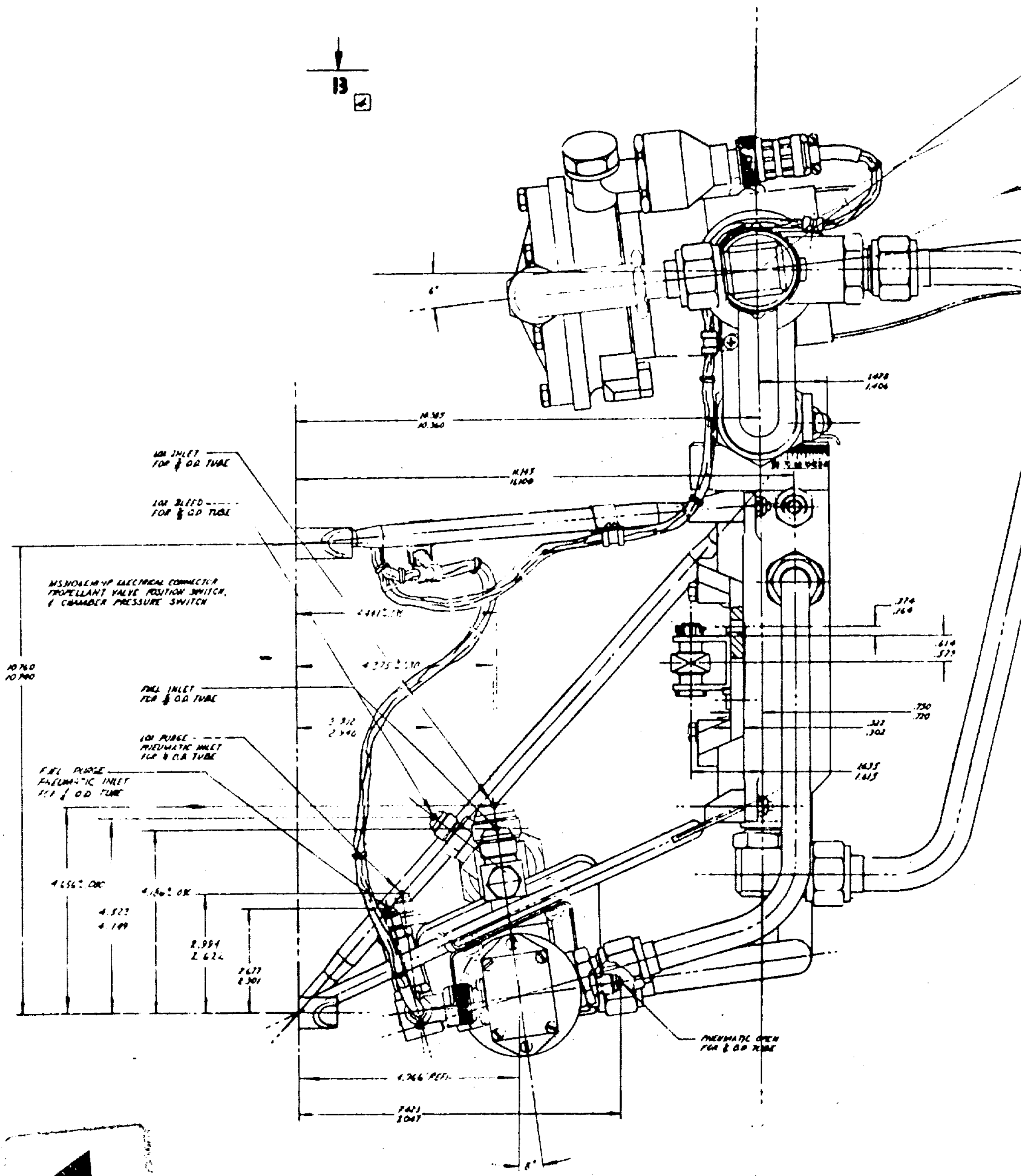
NOTE: UNLESS OTHERWISE SPECIFIED

REFERENCE ONLY

HEAT TREAT	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND APPLY PRIOR TO FINISH. 125 MACH SURF ROUGHNESS. TOLERANCES ON DECIMALS / ANGLES. HOLES NOTED "DRILL".	DR BY R A WOLF	CHK BY	ROCKETDYNE A DIVISION OF NORTH AMERICAN AVIATION, INC. CANOGA PARK, CALIFORNIA
FINISH	DO NOT SCALE PRINT			DIMENSIONS, CUSTOMER CONNECTION ROCKET ENGINE
MAT'L				CODE IDENT NO 02602 / SIZE J / 104654
				SCALE 1/4 / SHEET

104654

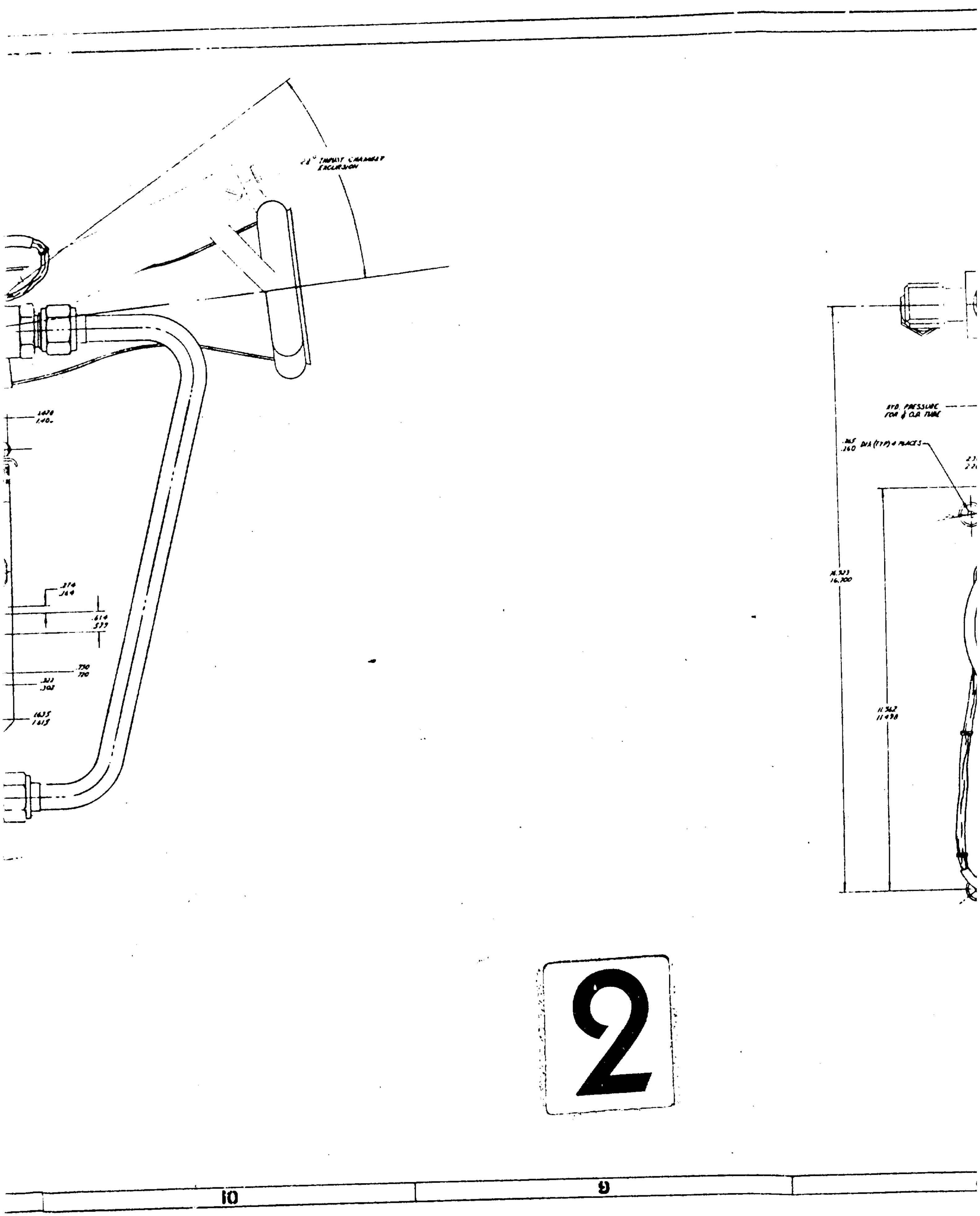
B

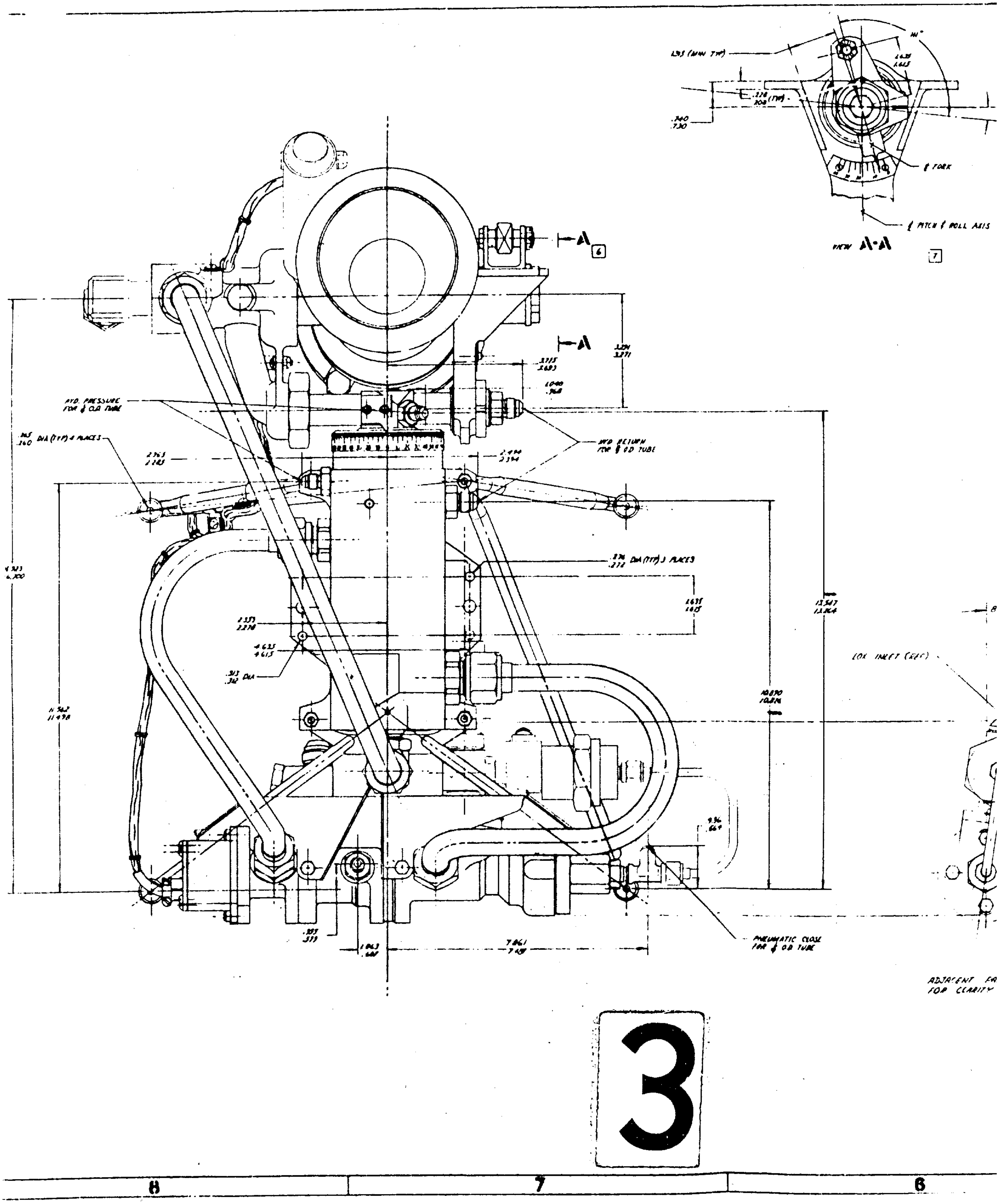


ELECTRICAL CONNECTOR
PROPELLANT VALVE POSITION SWITCH,
CHAMBER PRESSURE SWITCH
PNEUMATIC INLET

1

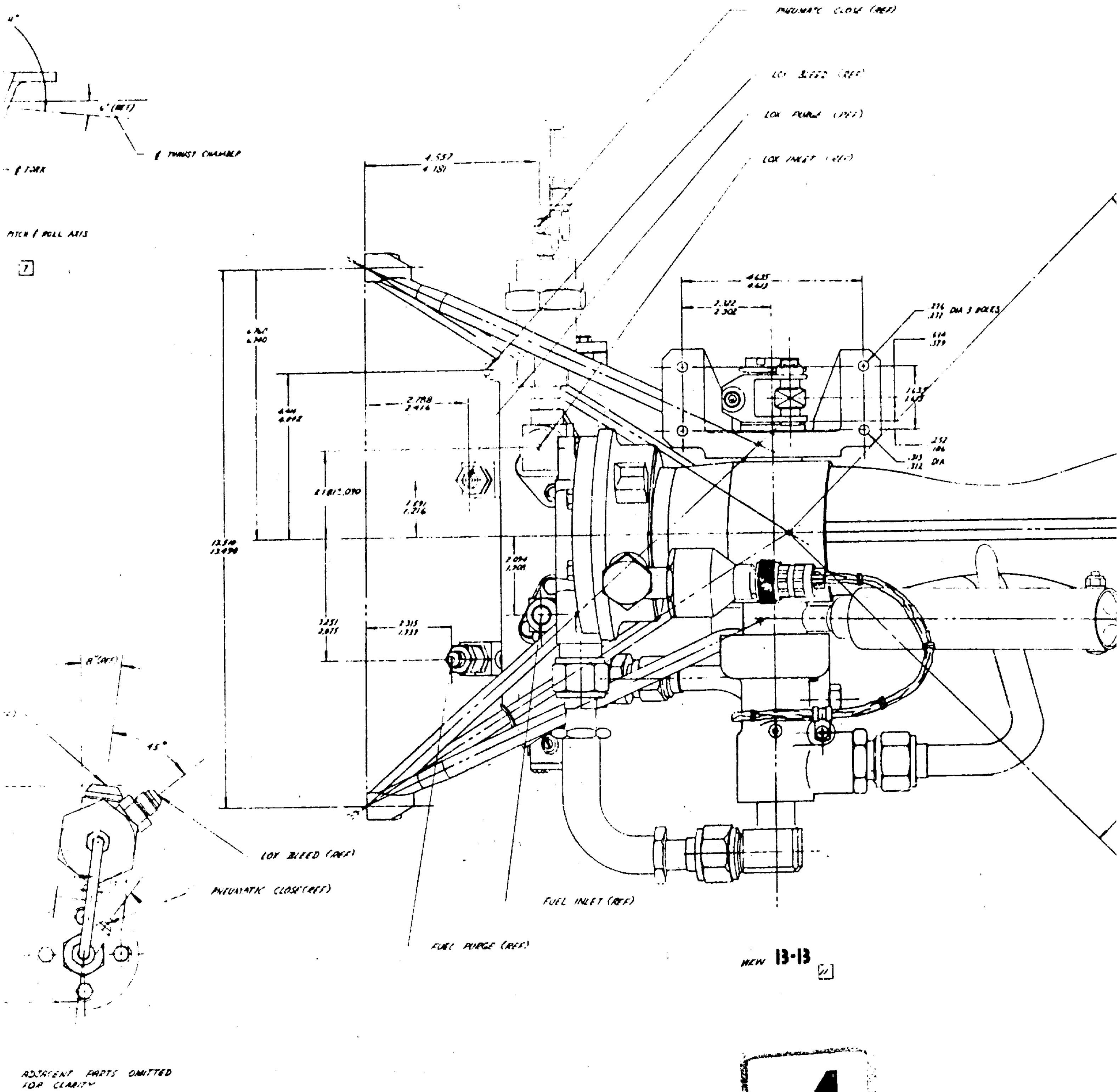
12 | 11


EXCURSION
.160
16.700
2
10
9

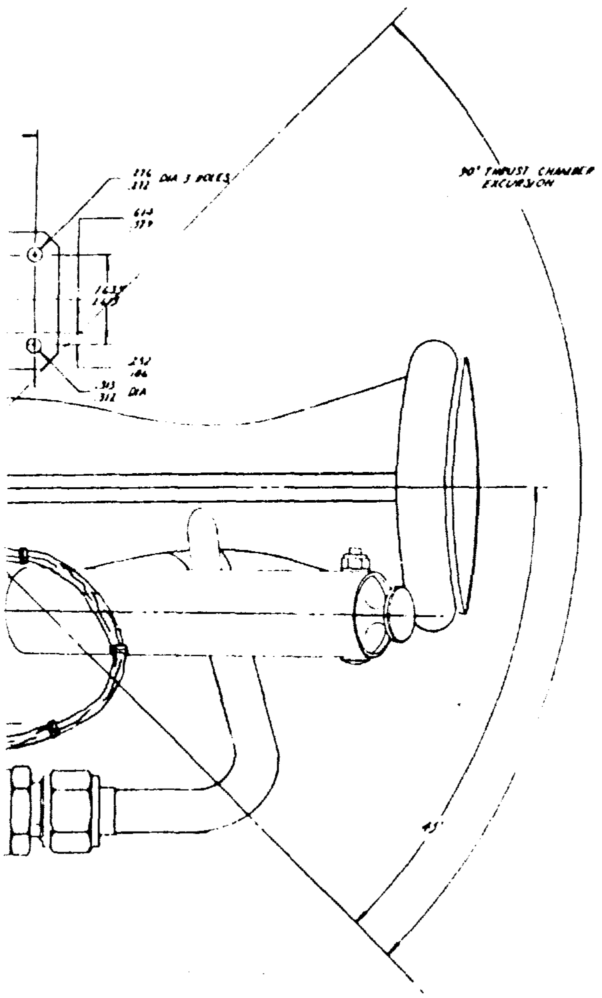


VIEW A-A
HYD. PRESSURE FOR ¼ O.D. TUBE
HYD RETURN FOR ¼ O.D. TUBE
PNEUMATIC CLOSE FOR ¼ O.D. TUBE
LOX INLET (REF)
ADJACENT FA
FOR CLARITY
8
7
6

3


PNEUMATIC CLOSE (REF)
LOX BLEED (REF)
LOX PURGE (REF)
LOX INLET (REF)
THRUST CHAMBER
PITCH ℄ ROLL AXIS
DIA 3 HOLES
DIA
LOX BLEED (REF)
PNEUMATIC CLOSE (REF)
FUEL INLET (REF)
FUEL PURGE (REF)
VIEW B-B
ADJACENT PARTS OMITTED
FOR CLARITY

4



5

1. FOR CUSTOMER CONNECTIONS ON XLR-101-NA-11.
NOTE: UNLESS OTHERWISE SPECIFIED

6

1. FOR CUSTOMER CONNECTIONS ON XLR-101-NA-11.

NOTE: UNLESS OTHERWISE SPECIFIED

DRILLED HOLE TOLERANCES

CUSTOMERS CONNECTION - VERNIER ENGINE

SCALE FULL

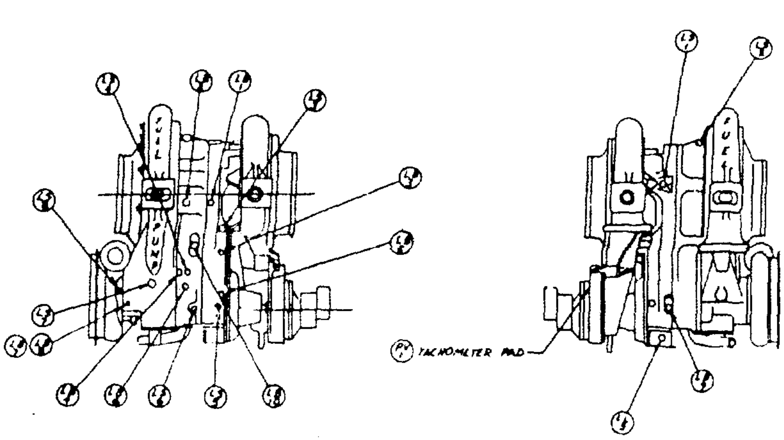
ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

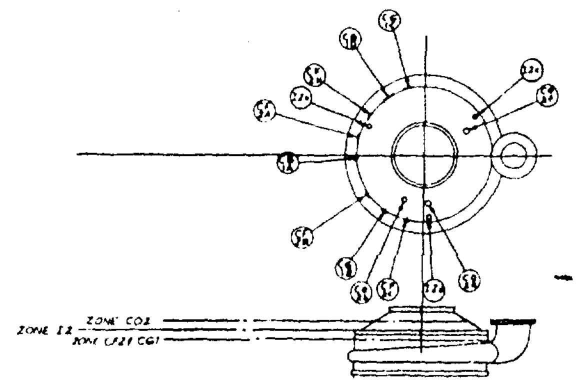
6633 CANOGA AVE. CANOGA PARK, CALIFORNIA

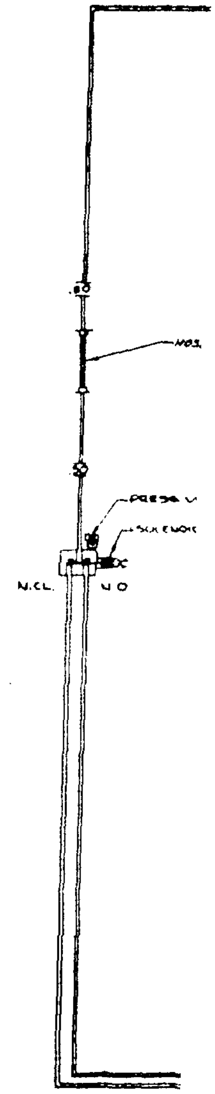
J

350724



TURBOPUMP TAP POINT LOCATIONS





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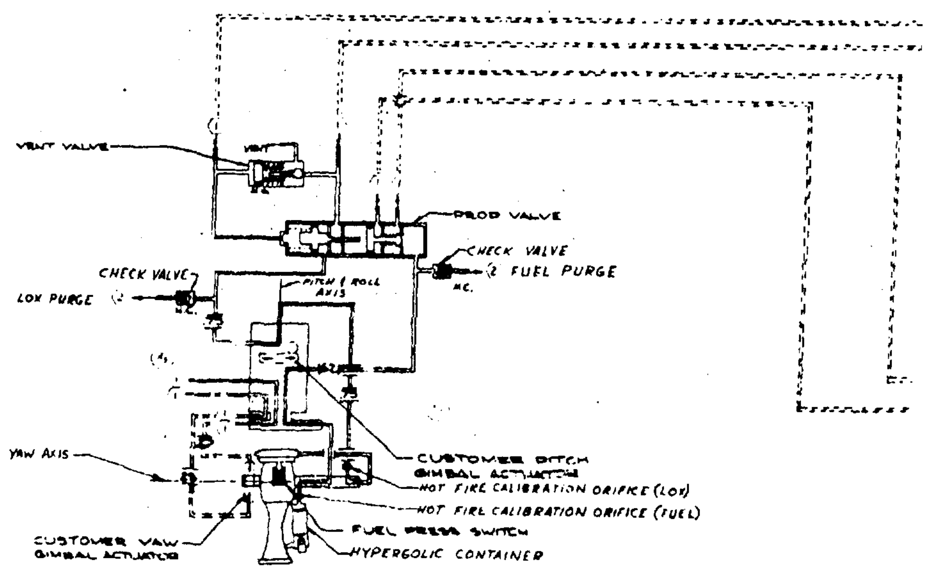
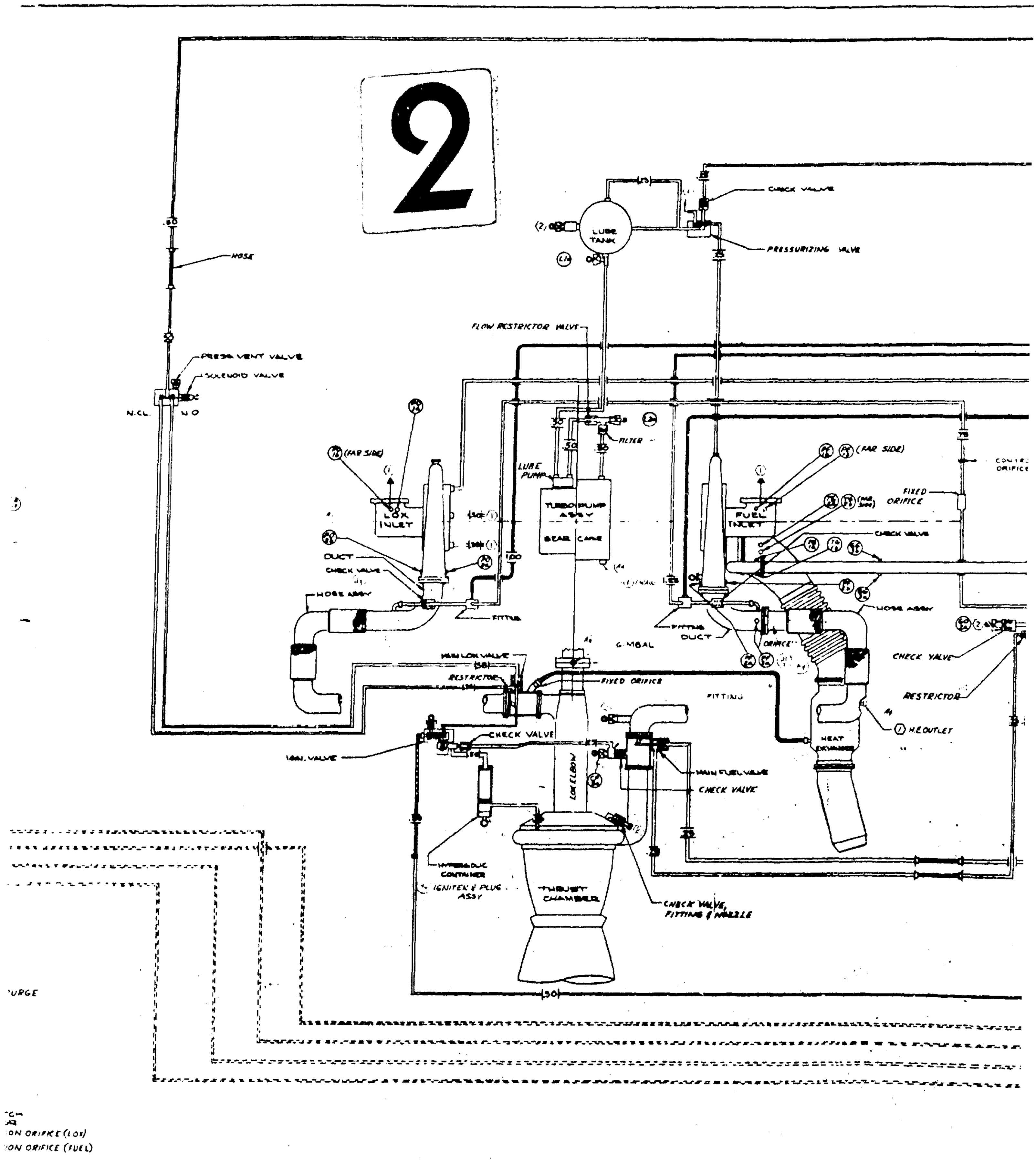
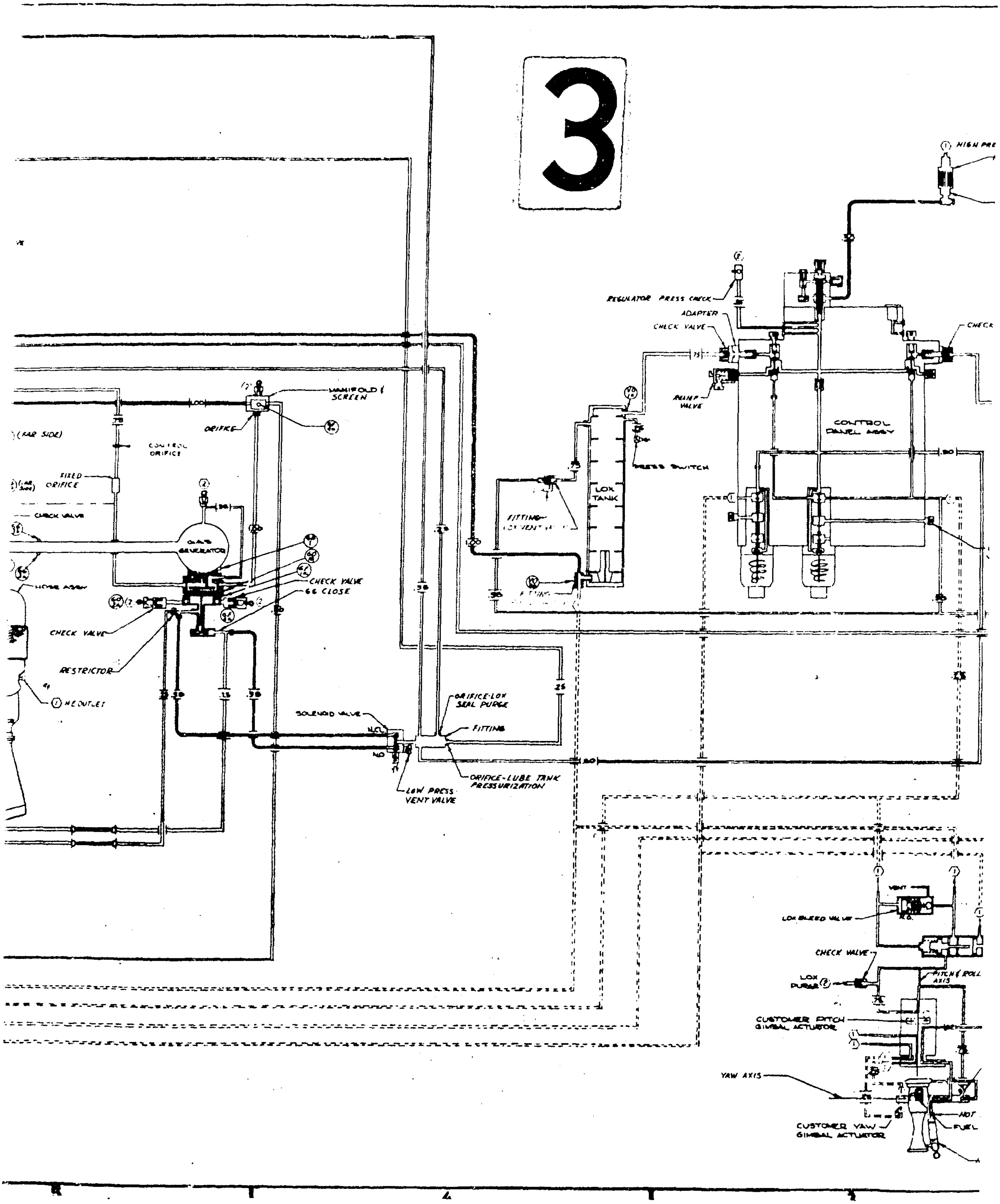
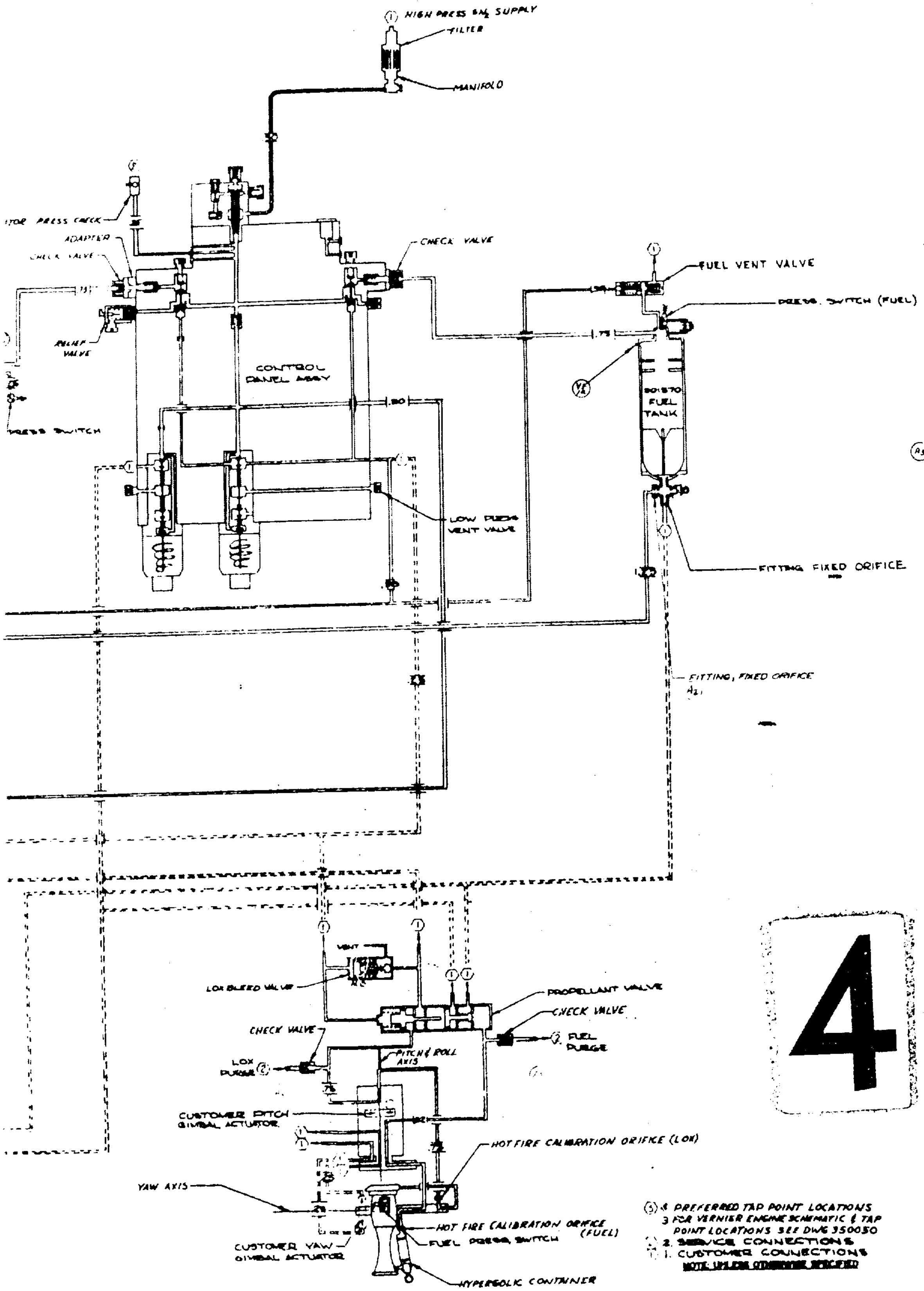



2
CHECK VALVE
LUBE TANK
PRESSURIZING VALVE
HOSE
FLOW RESTRICTOR VALVE
PRESS. VENT VALVE
SOLENOID VALVE
N.CL.
N.O.
FILTER
LUBE PUMP
TURBOPUMP ASSY
GEAR CASE
(FAR SIDE)
LOX INLET
FUEL INLET
FIXED ORIFICE
CONTROL ORIFICE
DUCT
HOSE ASSY
FITTING
GIMBAL
ORIFICE
MAIN LOX VALVE
RESTRICTOR
FIXED ORIFICE
FITTING
H.E. OUTLET
HEAT EXCHANGER
IGN. VALVE
LOX ELBOW
MAIN FUEL VALVE
HYPERGOLIC CONTAINER
IGNITER & PLUG ASSY
THRUST CHAMBER
CHECK VALVE, FITTING & NOZZLE
URGE
ON ORIFICE (LOX)
ON ORIFICE (FUEL)

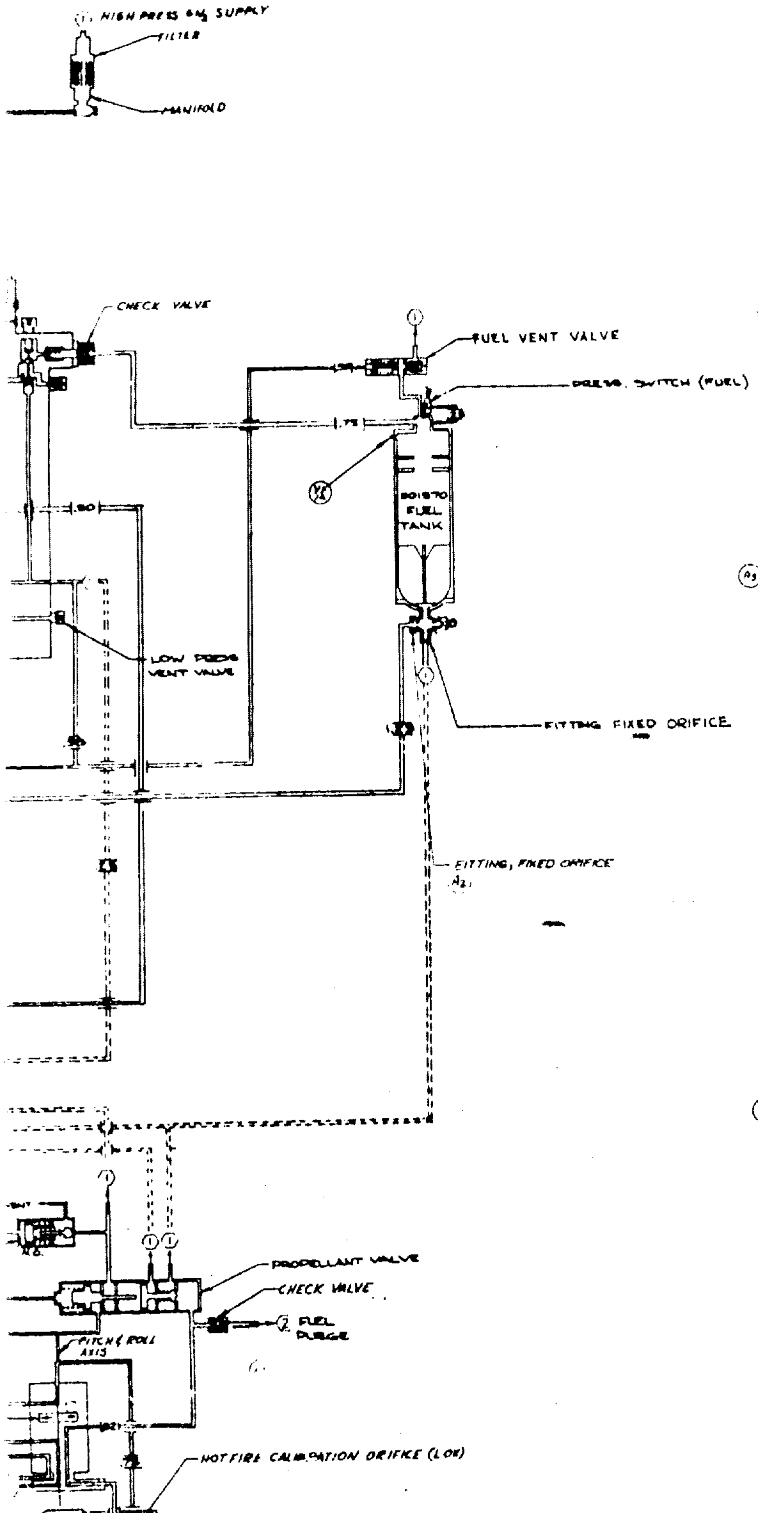

3
HIGH PRE
REGULATOR PRESS CHECK
ADAPTER
CHECK VALVE
CHECK
RELIEF VALVE
CONTROL PANEL ASSY
LOX TANK
PRESS SWITCH
FITTING
MANIFOLD & SCREEN
ORIFICE
(FAR SIDE)
CONTROL ORIFICE
FIXED ORIFICE
CHECK VALVE
GAS GENERATOR
HOSE ASSY
CHECK VALVE
66 CLOSE
RESTRICTOR
HE OUTLET
SOLENOID VALVE
ORIFICE-LOX SEAL PURGE
FITTING
ORIFICE-LUBE TANK PRESSURIZATION
LOW PRESS VENT VALVE
VENT
LOX BLEED VALVE
CHECK VALVE
LOX PURGE
PITCH & ROLL AXIS
CUSTOMER PITCH GIMBAL ACTUATOR
YAW AXIS
CUSTOMER YAW GIMBAL ACTUATOR
HOT
FUEL



(5) 4 PREFERRED TAP POINT LOCATIONS
3 FOR VERNIER ENGINE SCHEMATIC & TAP POINT LOCATIONS SEE DWG 350050
2. SERVICE CONNECTIONS
1. CUSTOMER CONNECTIONS
NOTE: UNLESS OTHERWISE SPECIFIED

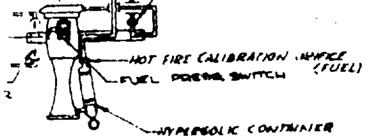
	ENGINE TAP	TAP LOCATION
(3)	CF1a	TC FUEL INLET MANIFOLD
	CF2a	TC FUEL INJECTION
	CF2b	TC FUEL INJECTION
	CF2c	TC FUEL INJECTION
	CF3a	TC FUEL INJECTION
(2)	CF3a	MAIN FUEL VALVE PRESS
(3)	CG1a	TC INJECTOR END
	CG1b	TC INJECTOR END
	CG1c	TC INJECTOR END
	CG1d	TC COMBUSTION AREA
(3)	CO2a	TC DOME OXIDIZER INJECTION
	CO2b	TC DOME OXIDIZER INJECTION
	CO2c	TC DOME OXIDIZER INJECTION
	CO2d	TC DOME OXIDIZER INJECTION
	CO2e	TC DOME OXIDIZER INJECTION
(3)	GF1a	GAS GEN FUEL MANIFOLD
(2)	GF2a	GAS GEN BLADE FUEL PURGE INLET
	GF4a	GAS GEN FUEL BOOTSTRAP
(3)	GG1	GAS GEN COMBUSTION CHAMBER
	GG3a	GAS GEN HOT GAS OUTLET
	GG3b	GAS GEN HOT GAS OUTLET
(3)	GO1a	GAS GEN OXIDIZER MANIFOLD
(2)	GO2a	GAS GEN BLADE OXID. VALVE INLET
(A3)	~~[illegible]~~	~~[illegible]~~
	~~[illegible]~~	~~[illegible]~~
	I2a	TC IGNITER FUEL
	I2b	TC IGNITER FUEL
	I2c	TC IGNITER FUEL
	~~[illegible]~~	~~[illegible]~~
(2)	L1a	LUBE OIL FILL
(2)	L2a	TURBOPUMP GEARBOX FLUSH
	L81	TURBOPUMP BEARING #1 OIL JET
	L82	TURBOPUMP BEARING #2 OIL JET
	L83	TURBOPUMP BEARING #3 OIL JET
	L84	TURBOPUMP BEARING #4 OIL JET
	L85	TURBOPUMP BEARING #5 OIL JET
	L86	TURBOPUMP BEARING #6 OIL JET
	L87	TURBOPUMP BEARING #7 OIL JET
	L88	TURBOPUMP BEARING #8 OIL JET
	L89	[illegible] OIL JET
	L810	[illegible] OIL JET
(3)	LL2	LUBE OIL MANIFOLD
	L31	TURBOPUMP BEARING #1 TEMP
	L32	TURBOPUMP BEARING #2 TEMP
	L33	TURBOPUMP BEARING #3 TEMP
	L34	TURBOPUMP BEARING #4 TEMP
	L35	TURBOPUMP BEARING #5 TEMP
	L36	TURBOPUMP BEARING #6 TEMP
	L37	TURBOPUMP BEARING #7 TEMP
	L38	TURBOPUMP BEARING #8 TEMP
(5)(1)	NN2a	[illegible] MANIFOLD PRESS CONTROL
(3)	PF1a	FUEL PUMP INLET
	PF1b	FUEL PUMP INLET
(3)	PF2a	FUEL PUMP OUTLET
	PF2b	FUEL PUMP OUTLET
	PF3a	FUEL PUMP OUTLET [illegible]
(3)	PO1a	OXIDIZER PUMP INLET
	PO1b	OXIDIZER PUMP INLET
(3)	PO2a	OXIDIZER PUMP OUTLET
	PO2b	OXIDIZER PUMP OUTLET
(A3)	~~[illegible]~~	~~[illegible]~~
(3)	TG1a	TURBINE INLET
	TG1b	TURBINE INLET
(3)	TG2a	TURBINE EXHAUST
	TG2b	TURBINE EXHAUST
(3)	[illegible]	TACHOMETER
	VO1a	OXIDIZER START TANK
(3)	VO2a	OXIDIZER SUPPLY TO VERNIERS
	WF1a	FUEL START TANK
	[illegible]	H.P HOSE OUTLET PRESSURE

	REVISIONS		
SYM	DESCRIPTION	DATE	APPROVED
A	1. MAY BE REWORKED 2. CANNOT BE REWORKED 3. RECORD CHANGE 4. RUN SHOP PRACTICE 5. PARTS MADE OK		
	1. RELOCATED CONTROL ORIFICE FROM ZONE 5 TO ZONE 8	4/5	
	2. REMOVED (FOR NJ) FUEL ONLY		
	3. REMOVED NOMINAL OR SIZE FILLED NOMINAL ORIFICE LOCATION RESTRICTION		
	4. ADDED (1) HEAT EXCHANGER OUTLET, THE AREA GIMBAL, (1) TURBOPUMP DRAIN, IGNITER ... TAP POINT	5/-	
	5. FITTING FIXED ORIFICE WAS FITTING & ORIFICE. 2 PLACES	2/4	



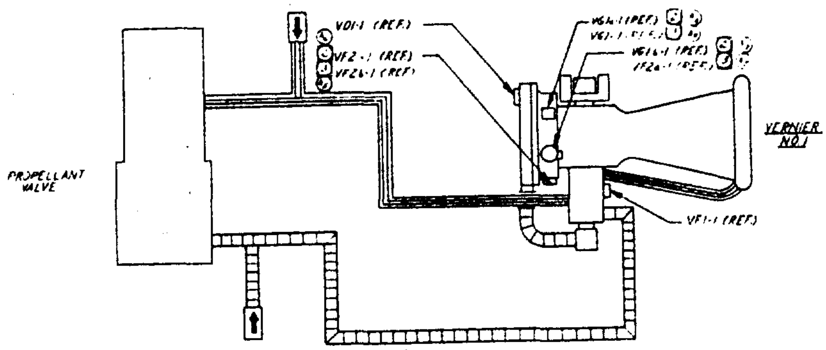
	VARIABLE IDENT	TAP LOCATION
(3)	CF1a	TC FUEL INLET MANIFOLD
	CF2a	TC FUEL INJECTION
	CF2b	TC FUEL INJECTION
	CF2c	TC FUEL INJECTION
	CF3A	TC FUEL INJECTION
(2)	CF5a	MAIN FUEL VALVE PRESS
(3)	CO1a	TC INJECTOR END
	CO1b	TC INJECTOR END
	CO1c	TC INJECTOR END
	CH1a	TC COMBUSTION AREA
(3)	CO2a	TC DOME OXIDIZER INJECTION
	CO2b	TC DOME OXIDIZER INJECTION
	CO2c	TC DOME OXIDIZER INJECTION
	CO2d	TC DOME OXIDIZER INJECTION
	CO2e	TC DOME OXIDIZER INJECTION
(3)	GF1a	GAS GEN FUEL MANIFOLD
(2)	GF3a	GAS GEN BLADE FUEL PURGE ...
	GF4a	GAS GEN FUEL BOOTSTRAP
(3)	GG1	GAS GEN COMBUSTION CHAMBER
	GG3a	GAS GEN HOT GAS OUTLET
	GG3b	GAS GEN HOT GAS OUTLET
(3)	GO1a	GAS GEN OXIDIZER MANIFOLD
(4)	GO2a	GAS GEN BLADE OXID. PURGE INLET
(A)	~~[illegible]~~	~~[illegible]~~
	~~[illegible]~~	~~[illegible]~~
	I2a	TC IGNITER FUEL
	I2b	TC IGNITER FUEL
	I2c	TC IGNITER FUEL
(A)	~~[illegible]~~	~~TC IGNITER VALVE~~
(2)	L1a	LUBE OIL FILL
(2)	L2a	TURBOPUMP GEARBOX FLUSH
	L01	TURBOPUMP BEARING #1 OIL JET
	L02	TURBOPUMP BEARING #2 OIL JET
	L03	TURBOPUMP BEARING #3 OIL JET
	L04	TURBOPUMP BEARING #4 OIL JET
	L05	TURBOPUMP BEARING #5 OIL JET
	L06	TURBOPUMP BEARING #6 OIL JET
	L07	TURBOPUMP BEARING #7 OIL JET
	L08	TURBOPUMP BEARING #8 OIL JET
	L09	#9 OIL JET
	L010	#10 OIL JET
(3)	L13	LUBE OIL MANIFOLD
	L31	TURBOPUMP BEARING #1 TEMP
	L32	TURBOPUMP BEARING #2 TEMP
	L33	TURBOPUMP BEARING #3 TEMP
	L34	TURBOPUMP BEARING #4 TEMP
	L35	TURBOPUMP BEARING #5 TEMP
	L36	TURBOPUMP BEARING #6 TEMP
	L37	TURBOPUMP BEARING #7 TEMP
	L38	TURBOPUMP BEARING #8 TEMP
(3)(1)	NN23	PNEU. MANIFOLD PRESS CONTROL
(3)	PF1a	FUEL PUMP INLET
	PF1b	FUEL PUMP INLET
(3)	PF2a	FUEL PUMP OUTLET
	PF2b	FUEL PUMP OUTLET
	PF3a	FUEL PUMP OUTLET QUAT
(3)	PO1a	OXIDIZER PUMP INLET
	PO1b	OXIDIZER PUMP INLET
(3)	PO2a	OXIDIZER PUMP OUTLET
	PO2b	OXIDIZER PUMP OUTLET
(A)	~~[illegible]~~	~~[illegible]~~
(3)	TG1a	TURBINE INLET
	TG1b	TURBINE INLET
(3)	TG2a	TURBINE EXHAUST
	TG2b	TURBINE EXHAUST
(3)	SP	TACHOMETER
	YO1a	OXIDIZER START TANK
(3)	VO2a	OXIDIZER SUPPLY TO VERNIERS
	YF1a	FUEL START TANK
	PF4	H.P HOSE OUTLET PRESSURE

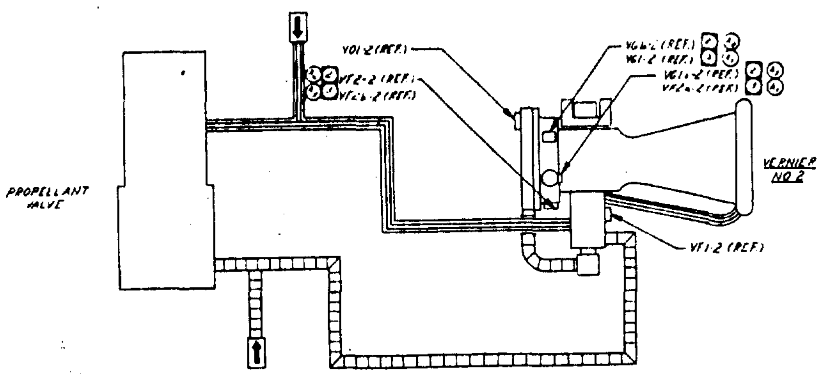
5



(3) 4. PREFERRED TAP POINT LOCATIONS
3. FOR VERNIER ENGINE SCHEMATIC & TAP POINT LOCATIONS SEE DWG 350050
(2) 2. SERVICE CONNECTIONS
(1) 1. CUSTOMER CONNECTIONS
NOTE: UNLESS OTHERWISE SPECIFIED

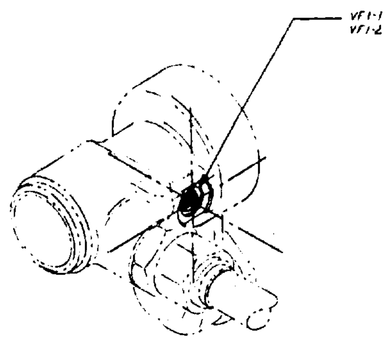
HEAT TREAT	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND APPLY PRIOR TO FINISH. 125/ MACH SURF ROUGHNESS. TOLERANCES ON DECIMALS .XX = ± .03, .XXX = ± .010, ANGLES ± 30'. HOLES NOTED "DRILL"	ROCKETDYNE, A DIVISION OF NORTH AMERICAN AVIATION, INC. CANOGA PARK, CALIFORNIA — NEOSHO, MISSOURI
FINISH	DO NOT SCALE PRINT	SCHEMATIC INSTRUMENTATION & TAP POINT LOCATION
		CODE IDENT NO. 02602 — SIZE J — 702827



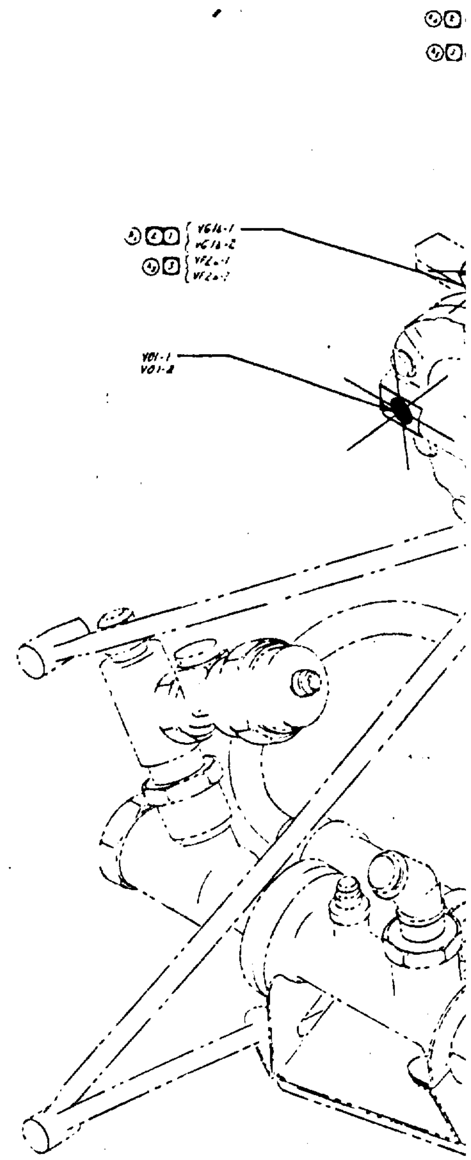


LINE CODE	
OXIDIZER	
FUEL	

1



VIEW A 4



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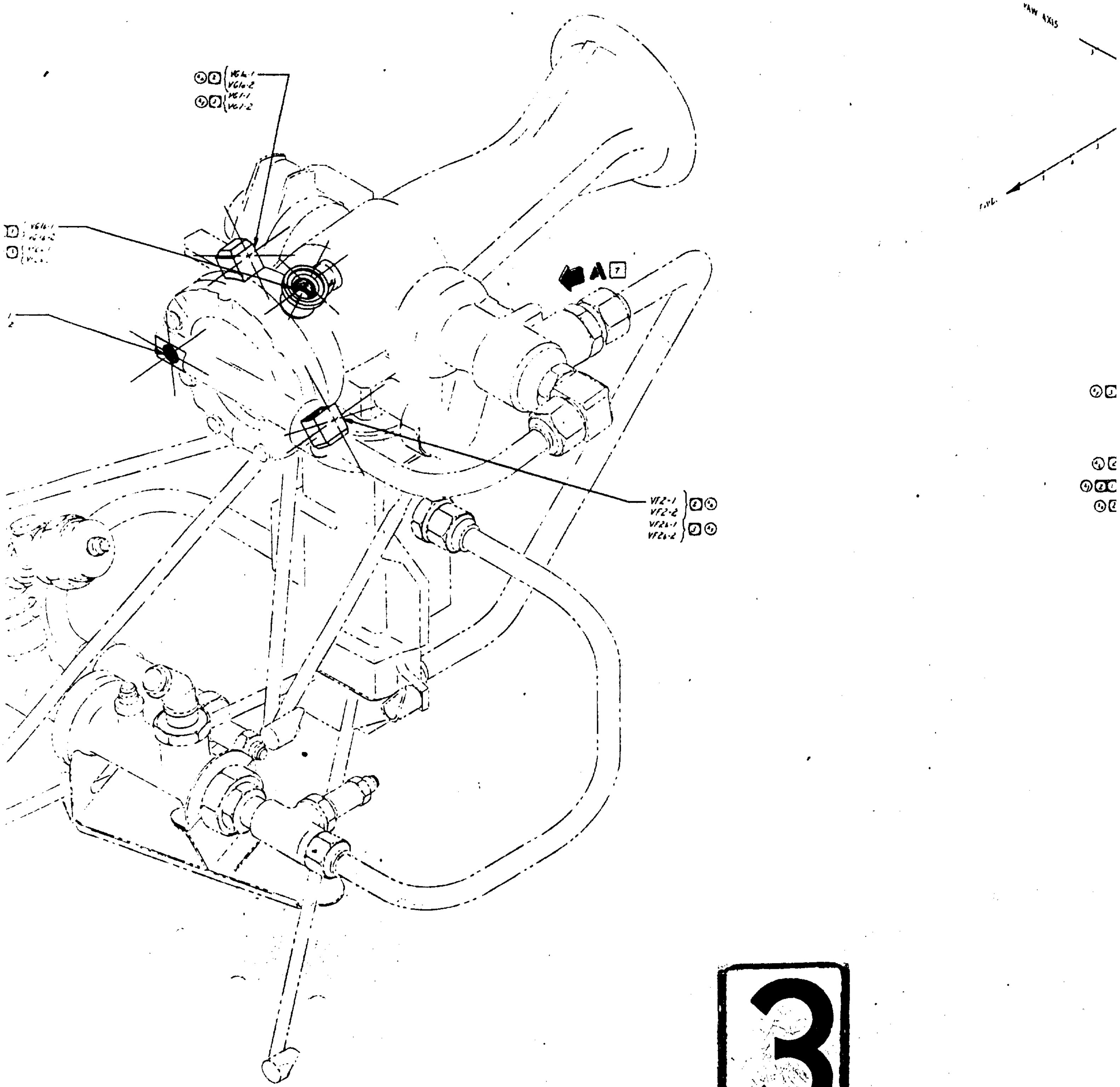
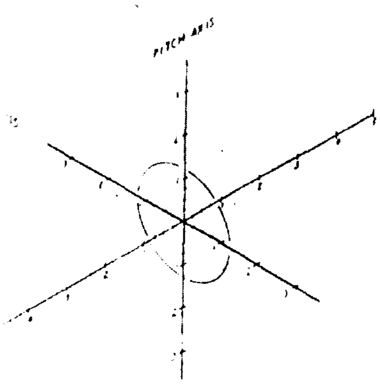


3

	A	
2	1	REMOVED ... RELIABILI...
2	2	ADDED ...
3	3	ADDED ...
3	4	ADDED ...
3	5	ADDED VI... VF2a-2, V...
3	6	ADDED ...
	B	
2	1.	IN EFFEC... XLR-101-A...
	C	
2	1	ADDED ... BLOCK ... LR-101-...
1	2.	ADDED ... FOR R...



SCALE ... INCHES

TAP NO	DESCRIPTION	TAP SIZE	TYPE	ZONE
VF2a-1	THRUST CHAMBER FUEL INJECTION PRESSURE	1/4 OD TUBE	AND10050	5
VF2a-2	THRUST CHAMBER FUEL INJECTION PRESSURE	1/4 O.D. TUBE	AND10050	5
VF2a-1	THRUST CHAMBER FUEL INJECTION PRESSURE	1/4 OD TUBE	AND10050	5
VF2a-2	THRUST CHAMBER FUEL INJECTION PRESSURE	1/4 O.D. TUBE	AND10050	5
VG1-1	THRUST CHAMBER COMBUSTION PRESSURE	[illegible] UNF-3B	HI-TEMP	5
VG1-2	THRUST CHAMBER COMBUSTION PRESSURE	[illegible] UNF-3B	HI-TEMP	5
VF1-1	TRUNNION HOUSING FUEL PRESSURE	1/4 OD TUBE	AND10050	7
VF1-2	TRUNNION HOUSING FUEL PRESSURE	1/4 O.D. TUBE	AND10050	7
VF2-1	THRUST CHAMBER FUEL INJECTION PRESSURE	1/4 O.D. TUBE	AND10050	5
VF2-2	THRUST CHAMBER FUEL INJECTION PRESSURE	1/4 O.D. TUBE	AND10050	5
VG1b-1	THRUST CHAMBER COMBUSTION PRESSURE	1/4-16 UNF-3B	HI-TEMP	5
VG1b-2	THRUST CHAMBER COMBUSTION PRESSURE	1/4-16 UNF-3B	HI-TEMP	5
VG1a-1	THRUST CHAMBER COMBUSTION PRESSURE	1/4-20 UNF-3B	HI-TEMP	5
VG1a-2	THRUST CHAMBER COMBUSTION PRESSURE	1/4-20 UNF-3B	HI-TEMP	5
VO1-1	THRUST CHAMBER OXIDIZER INJECTION PRESSURE	1/4-20 UNF-3B	LO-TEMP	5
VO1-2	THRUST CHAMBER OXIDIZER INJECTION PRESSURE	1/4-20 UNF-3B	LO-TEMP	5

TAP CODE SYSTEM		
FIRST COLUMN CAPITAL LETTER DESIGNATES	LETTER	COMPONENT OR SYS
MAJOR COMPONENT (OR BASIC SUPPORT	V	VERNIER
SYSTEM)		
SECOND COLUMN CAPITAL LETTER DESIGNATES	LETTER	DESIGNATION
MEDIUM BEING SENSED OR THE OPERATING	F	FUEL
FEATURE CONNECTED WITH THE TAP	G	HOT GAS
	O	OXIDIZER
THIRD COLUMN NUMBER IDENTIFIES TAP ON THE COMPONENT OR		
IN THE SYSTEM		
FOURTH COLUMN LETTER, LOWER CASE, SIGNIFIES MORE THAN		
ONE TAP OF SAME MEASURE LOCATED IN A COMMON PLANE		
HYPHEN IN FIFTH COLUMN INDICATES NECESSITY OF		
FURTHER IDENTIFICATION		
SIXTH COLUMN INDICATES THRUST CHAMBER NUMBER IN		
A MULTIPLE CHAMBER CONFIGURATION		

3	NA334801	& SUBS	LR101-NA-11
3	NA334081	& SUBS	XLR-101-NA-9
2	NA334001	NA334080	XLR-101-NA-5
	ENGINE	THRU	MODEL
	EFFECTIVE ON		

4

FOR REFERENCE ONLY

2. REFER TO 303402 FOR EQUIPMENT NECESSARY TO CALIBRATE
1. TAP DESIGNATIONS FOR XLR 101-NA-5 ENGINE

NOTE: UNLESS OTHERWISE SPECIFIED

DRILLED HOLE TOLERANCES

INSTRUME... TAP...
VERNIER ... (ISOME...

SCALE 1/2

3 2 1

57

ZONE	SYM	REVISIONS		DATE	APPROVAL
	A				
2	1	REMOVED GENERAL NOTE 3 RELIABILITY CATEGORY	3		
2	2	ADDED EFFECT ON BLOCK			
	3	ADDED TO VF...			
	4	ADDED TO VF...			
	5	ADDED VF2... VF2... VF21... VF21-2, VH-1, VH-2 ...			
	6	ADDED TO VF2-1 & VF2-2		4 28 58	S. KRUY
	B				
2	1.	IN EFFECTIVITY BLOCK XLR-101-NA-9 WAS XLR-101-NA-5	3		
	C				
2	1	ADDED IN EFFECTIVE ON BLOCK 3 NA334801 & SUBS LR101-NA-11	3		
1	2.	ADDED ABOVE TITLE BLOCK FOR REFERENCE ONLY.		6-11-63	

DESCRIPTION	TAP SIZE	TYPE	ZONE
FUEL INJECTION PRESSURE	O.D. TUBE	AND10050	5
FUEL INJECTION PRESSURE	O.D. TUBE	AND10050	5
FUEL INJECTION PRESSURE	O.D. TUBE	AND10050	5
FUEL INJECTION PRESSURE	O.D. TUBE	AND10050	5
COMBUSTION PRESSURE	UNF-3B	HI-TEMP	5
COMBUSTION PRESSURE	UNF-3B	HI-TEMP	5
SING FUEL PRESSURE	O.D. TUBE	AND10050	7
SING FUEL PRESSURE	O.D. TUBE	AND10050	7
FUEL INJECTION PRESSURE	O.D. TUBE	AND10050	5
FUEL INJECTION PRESSURE	O.D. TUBE	AND10050	5
COMBUSTION PRESSURE	UNF-3B	HI-TEMP	5
COMBUSTION PRESSURE	UNF-3B	HI-TEMP	5
COMBUSTION PRESSURE	20UNF-3B	HI-TEMP	5
COMBUSTION PRESSURE	20UNF-3B	HI-TEMP	5
OXIDIZER INJECTION PRESSURE	20UNF-3B	LO-TEMP	5
OXIDIZER INJECTION PRESSURE	20UNF-3B	LO-TEMP	5

TAP CODE SYSTEM		
PITAL LETTER DESIGNATES	LETTER	COMPONENT OF SYS
NT (OR BASIC SUPPORT	V	VERNIER
LETTER DESIGNATES	LETTER	DESIGNATION
USED OR THE OPERATING	F	FUEL
TED WITH THE TAP	G	HOT GAS
	O	OXIDIZER
NUMBER DENTIFIES TAP ON THE COMPONENT OF		
LETTER LOWER CASE SIGNIFIES MORE THAN ONE MEASURE LOCATED IN A COMMON PLANE		
TH COLUMN INDICATES NECESSITY OF NTIFICATION		
N INDICATES THRUST CHAMBER NUMBER IN CHAMBER CONFIGURATION		

3 NA334801	& SUBS	LR101-NA-11
NA334081	& SUBS	XLR-101-NA-9
NA334001	NA334080	XLR-101-NA-5
ENGINE	THRU	MODEL
EFFECTIVE ON		

5

FOR REFERENCE ONLY

1. LATTER TO 303402 FOR EQUIPMENT NECESSARY TO CALIBRATE
TAP DESIGNATIONS FOR XLR 101-NA-5 ENGINE

NOTE: UNLESS OTHERWISE SPECIFIED

INSTRUMENTATION TAPS VERNIER ENGINE (ISOMETRIC)

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.

SIZE J 350050

SCALE 1/4

5-7

ELECTRICAL SYSTEM

Twenty-five to 30 volts dc (to the main engine electrical relay box) will be maintained until 0.5 second after all starting sequences have been completed, and 20 to 30 volts dc thereafter. The power required is 800 watts maximum for starting, and 300 watts is required for flight operation. The command cutoff signal shall have a minimum current capacity of 0.30 ampere and shall be sustained for a minimum of 0.10 second. Electrical supply for the heaters during preflight is 115 volts ac at 60 to 400 cps. The maximum ground power supply shall be 3000 watts.

Nominal power requirement profile charts are presented in Fig. 3, 4, and 5. Drawing 900100 is the electrical system schematic for the LV-2A propulsion system.

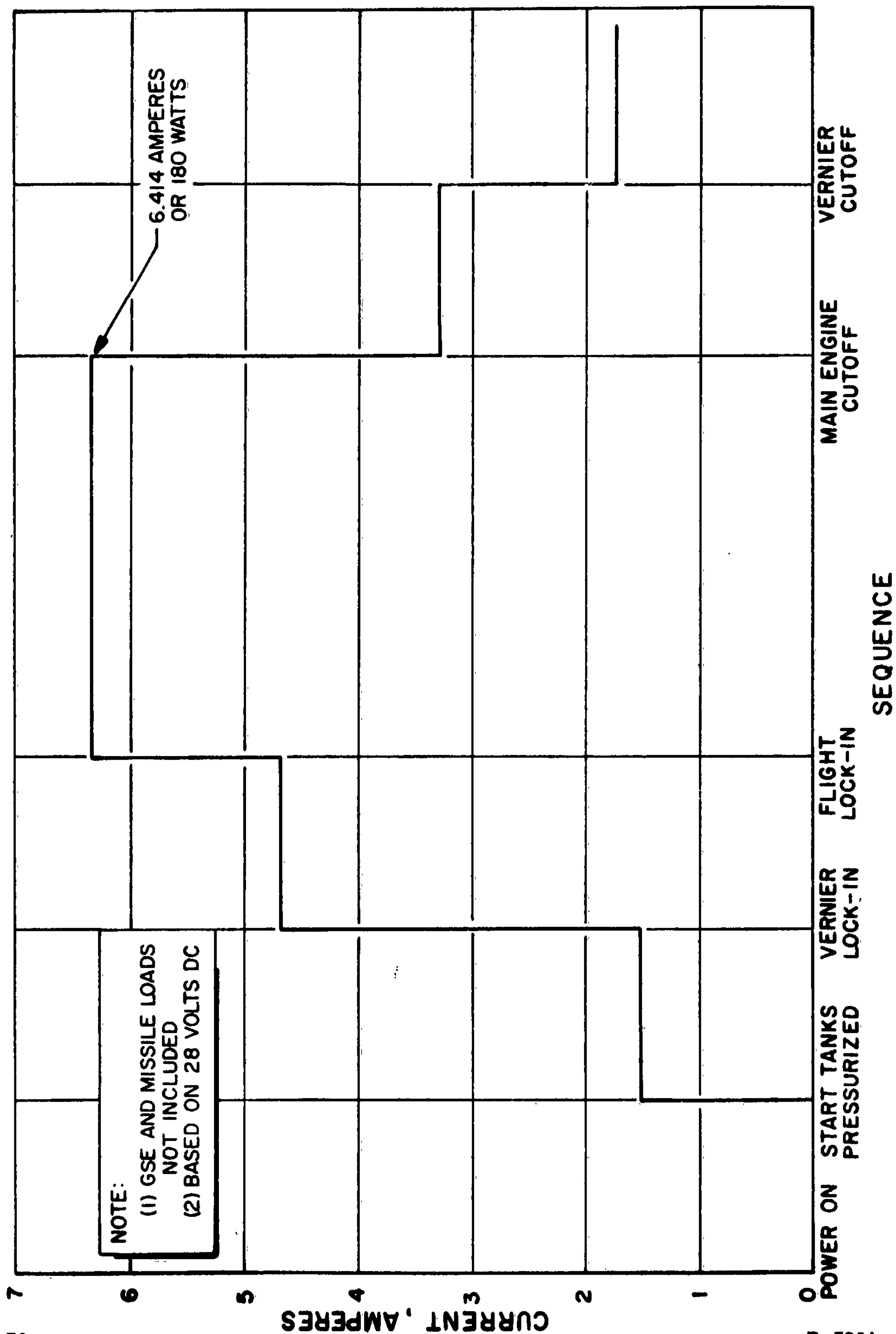


Figure 3. Direct Current Requirements

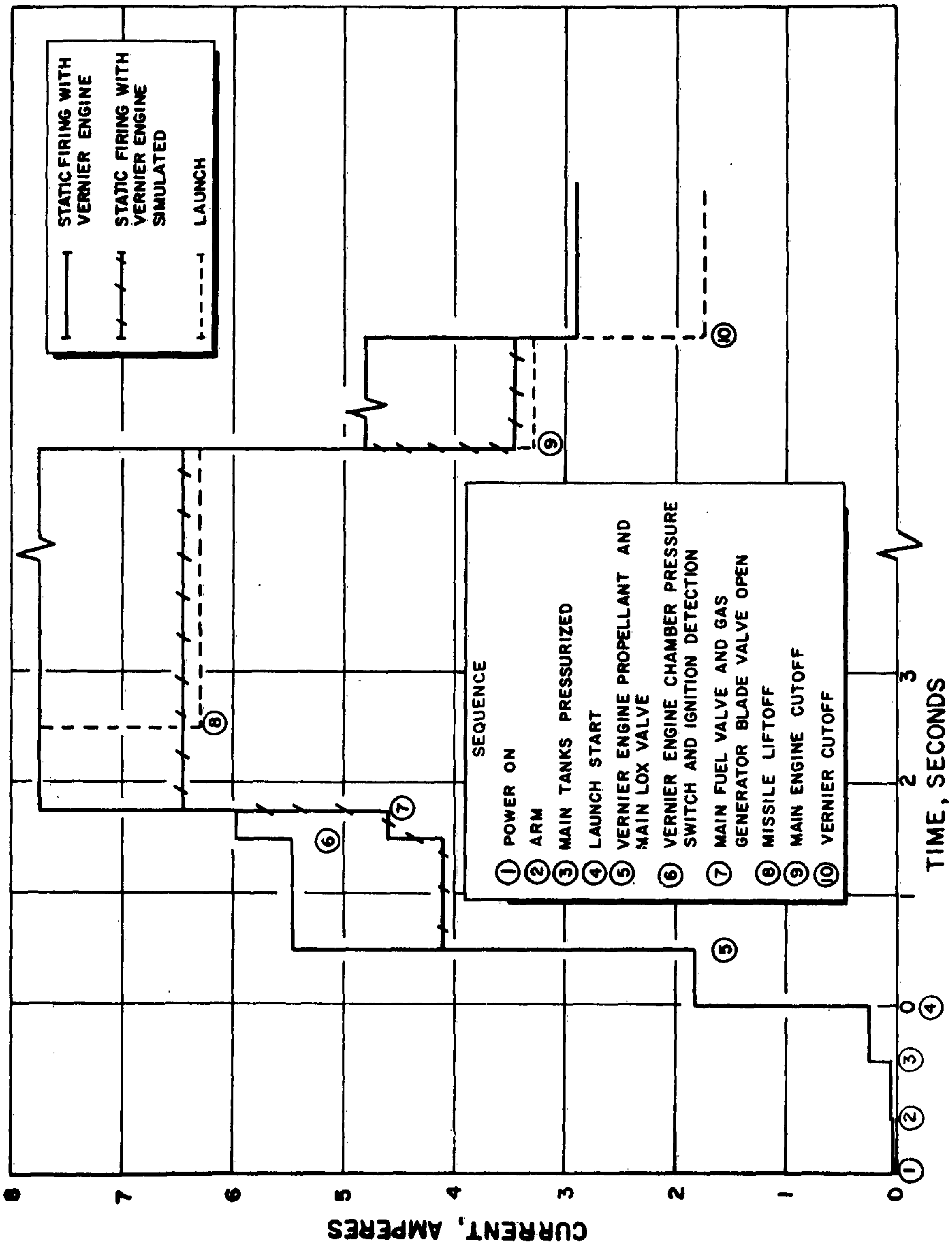


Figure 4. Direct Current Requirements (When Operated With R&D Ground Support Equipment)

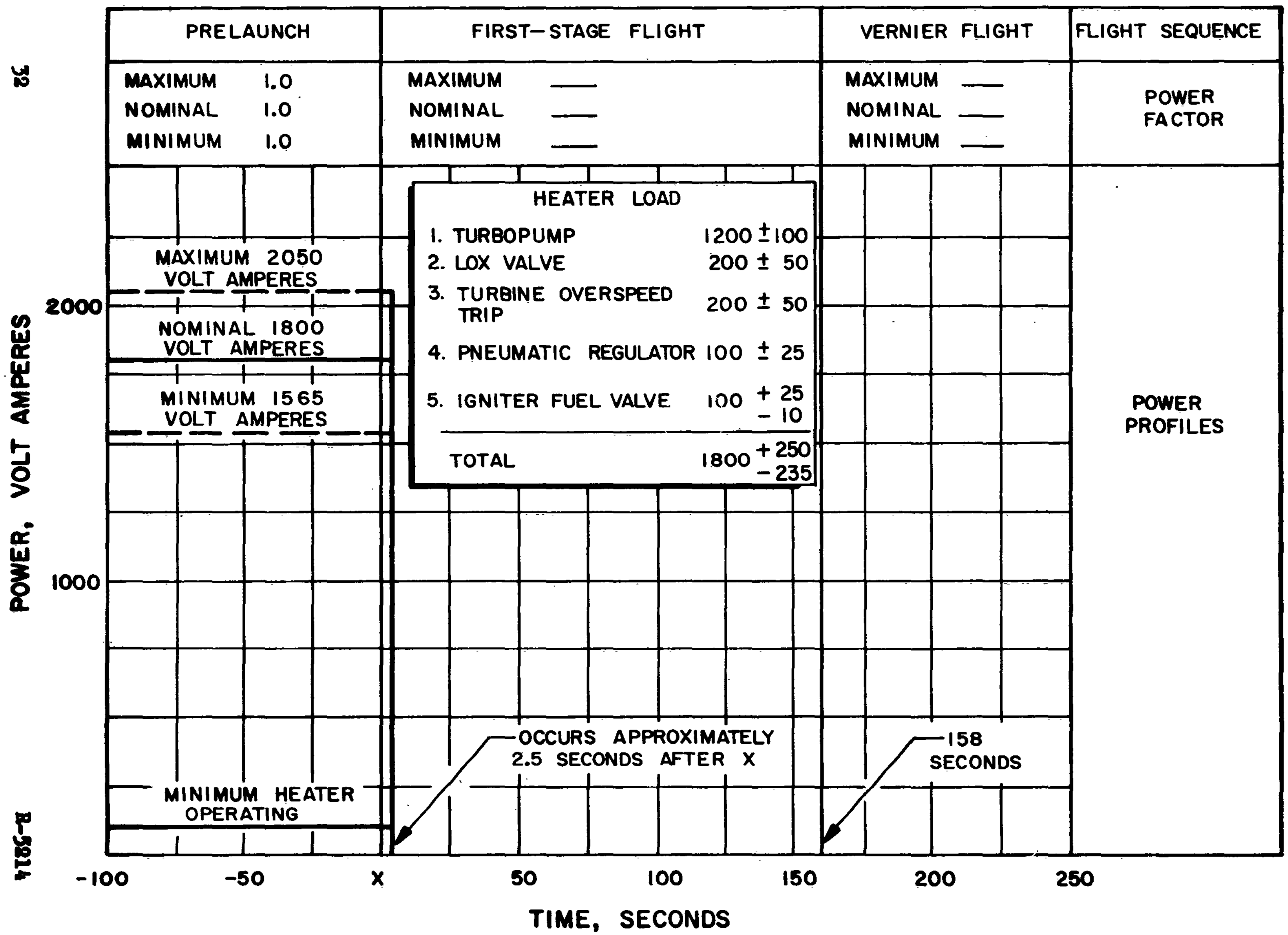
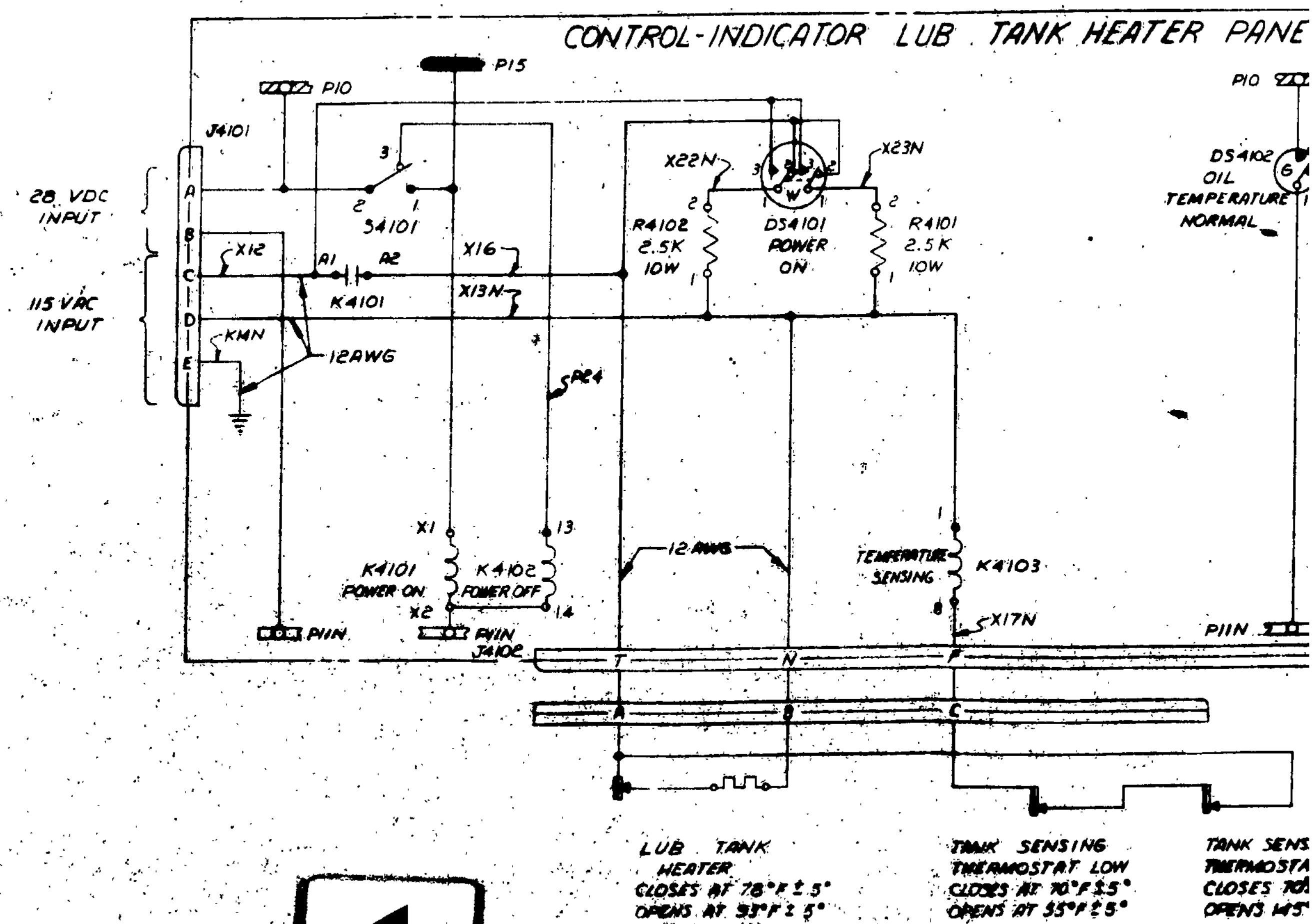
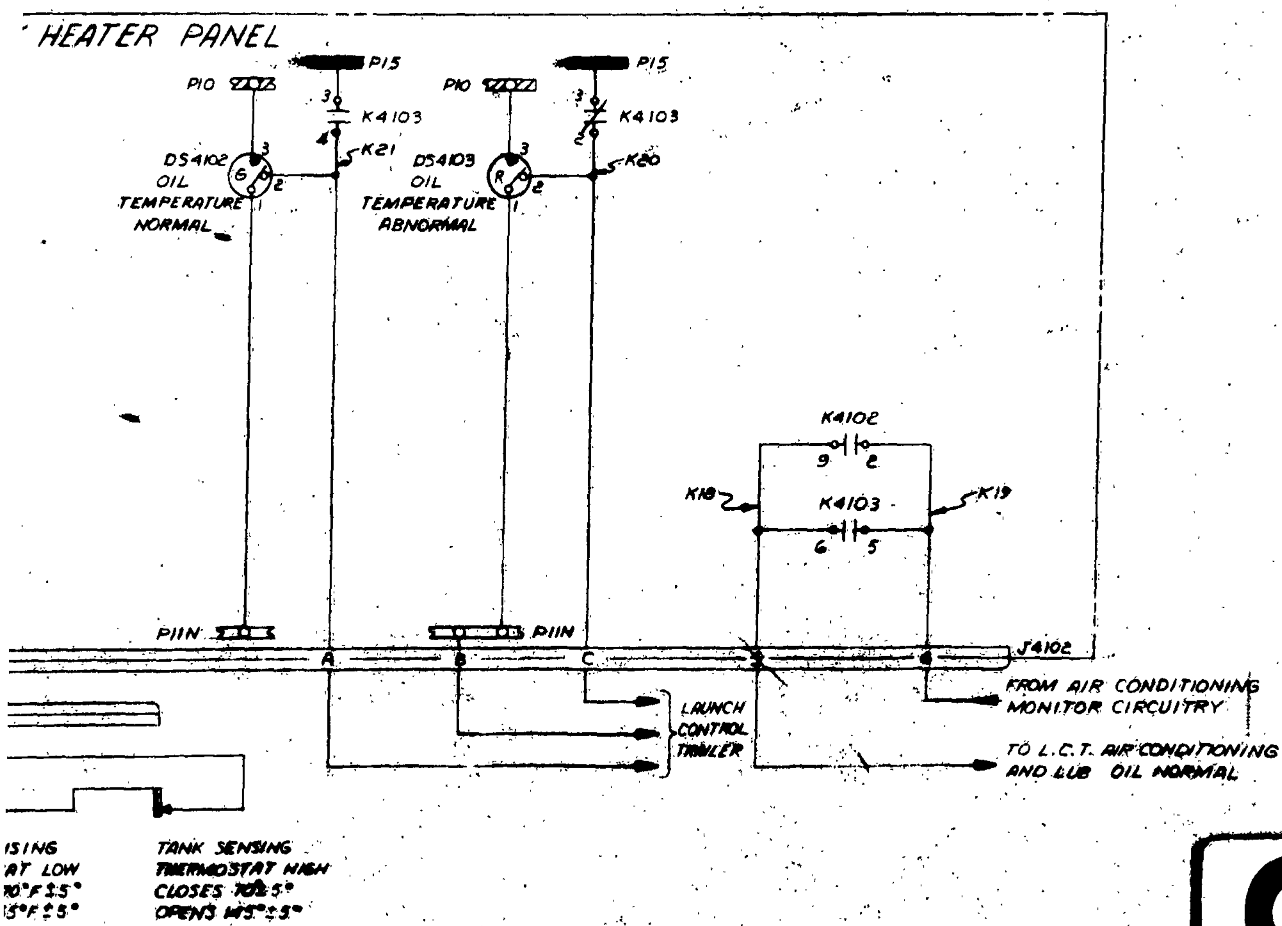


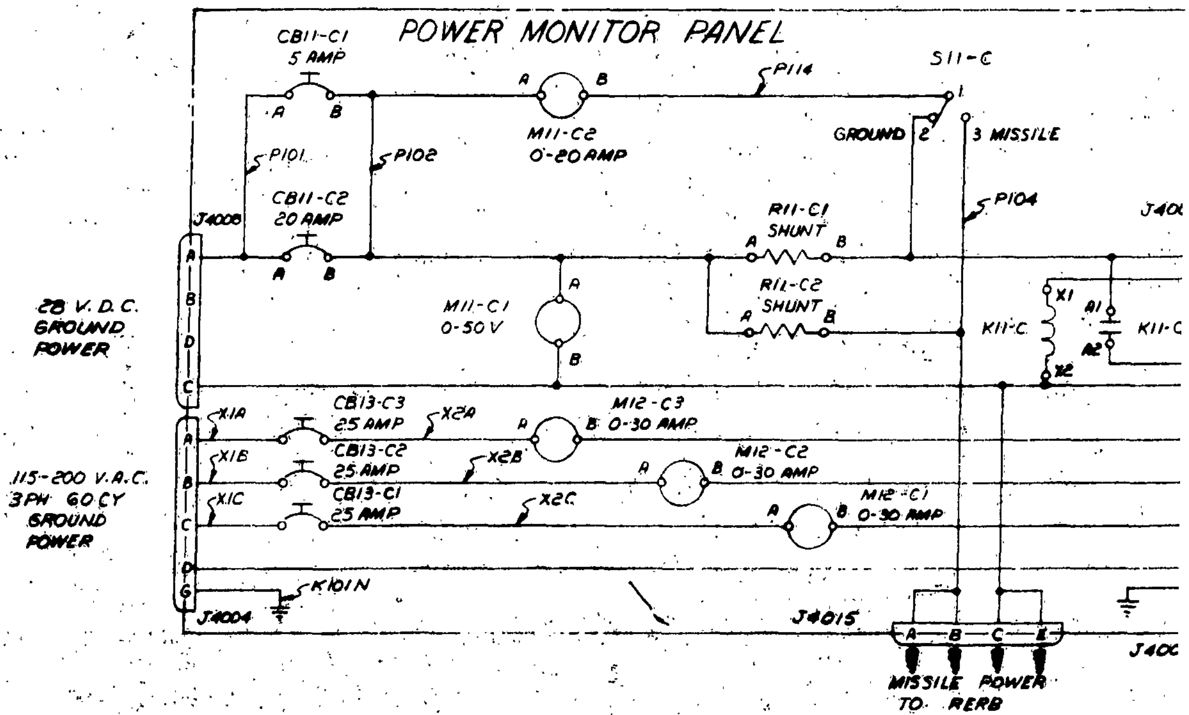
Figure 5 . Alternating Current Requirements


CONTROL-INDICATOR LUB TANK HEATER PANE
P15
P10
J4101
28 VDC INPUT
115 VAC INPUT
S4101
K4101
X12
X16
X13N
12AWG
KMN
X22N
X23N
R4102 2.5K 10W
DS4101 POWER ON
R4101 2.5K 10W
DS4102 OIL TEMPERATURE NORMAL
K4101 POWER ON
K4102 POWER OFF
P11N
J4102
TEMPERATURE SENSING
K4103
X17N
LUB TANK HEATER CLOSES AT 78°F ± 5° OPENS AT 93°F ± 5°
TANK SENSING THERMOSTAT LOW CLOSES AT 70°F ± 5° OPENS AT 55°F ± 5°
TANK SENS THERMOSTA CLOSES 70 OPENS 145

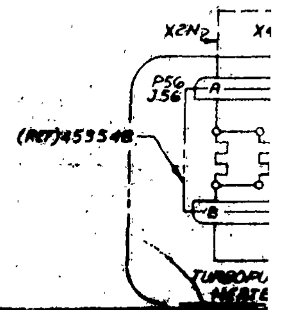
1


HEATER PANEL
P15
P10
K4103
K21
K20
DS4102
OIL
TEMPERATURE
NORMAL
DS4103
OIL
TEMPERATURE
ABNORMAL
K4102
K4103
K18
K19
P11N
J4102
A
B
C
FROM AIR CONDITIONING
MONITOR CIRCUITRY
LAUNCH
CONTROL
TRAILER
TO L.C.T. AIR CONDITIONING
AND LUB OIL NORMAL
TANK SENSING
THERMOSTAT HIGH
CLOSES 70±5°
OPENS 115°±5°

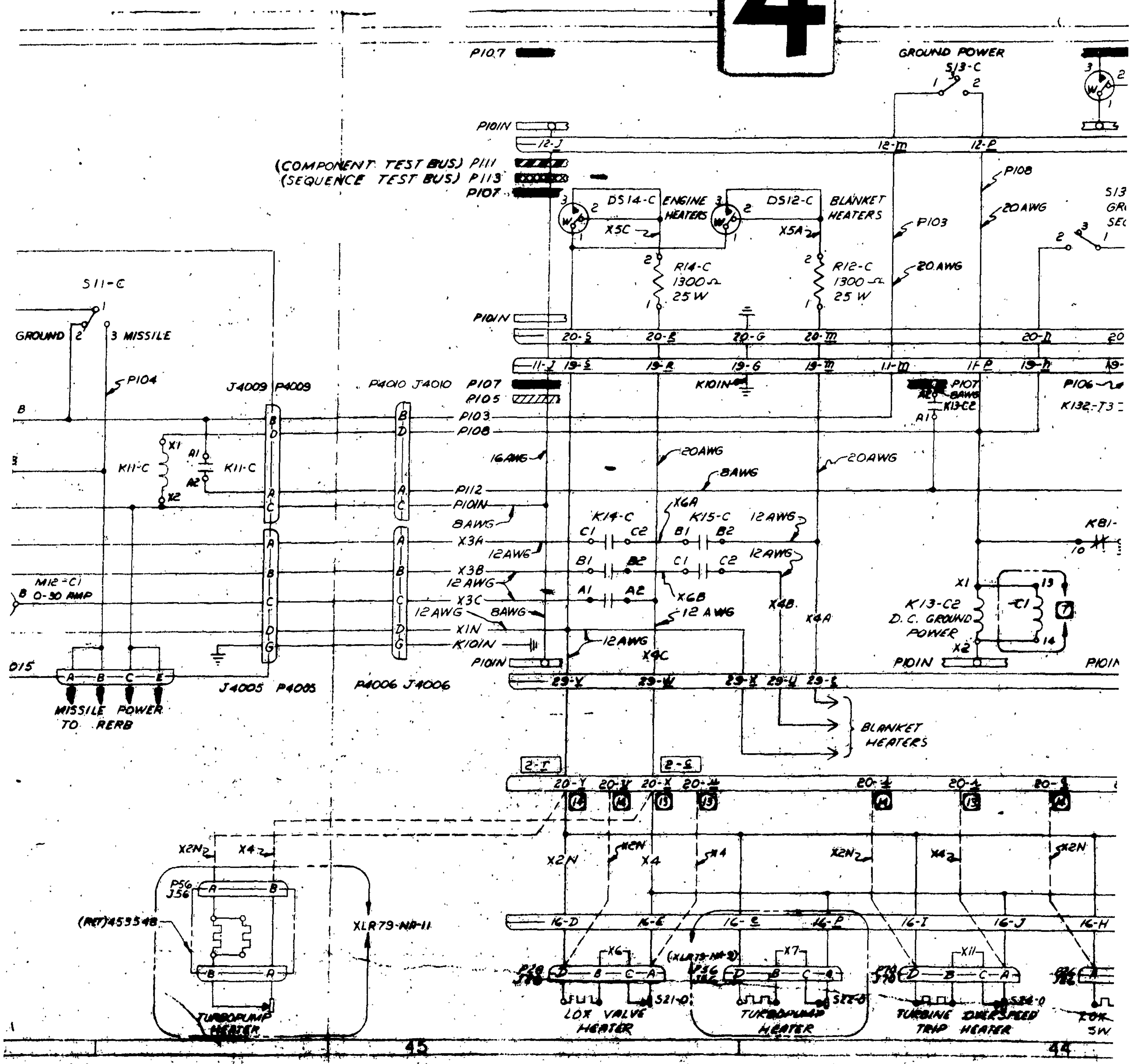
2


POWER MONITOR PANEL
CB11-C1
5 AMP
A
B
M11-C2
0-20 AMP
P114
S11-C
GROUND
3 MISSILE
P101
P102
P104
CB11-C2
20 AMP
J4008
R11-C1
SHUNT
R11-C2
SHUNT
M11-C1
0-50 V
K11-C
X1
X2
A1
A2
28 V. D.C.
GROUND
POWER
CB13-C3
25 AMP
X1A
X2A
M12-C3
0-30 AMP
X1B
CB13-C2
25 AMP
X2B
M12-C2
0-30 AMP
X1C
CB13-C1
25 AMP
X2C
M12-C1
0-30 AMP
115-200 V.A.C.
3PH 60 CY
GROUND
POWER
K101N
J4004
J4015
MISSILE POWER
TO RERB

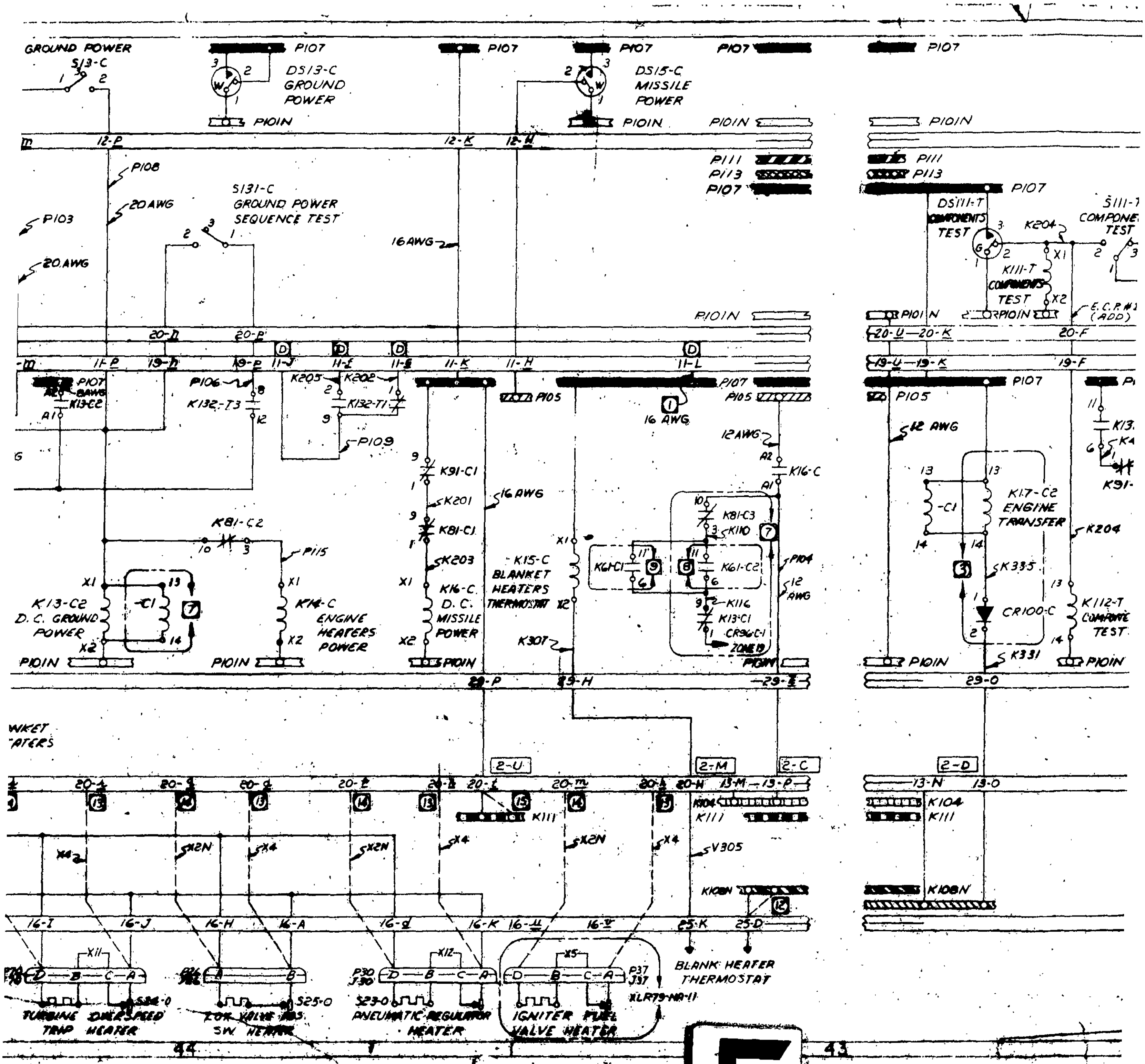
3


X2N
P56
J56
(REF)45354B

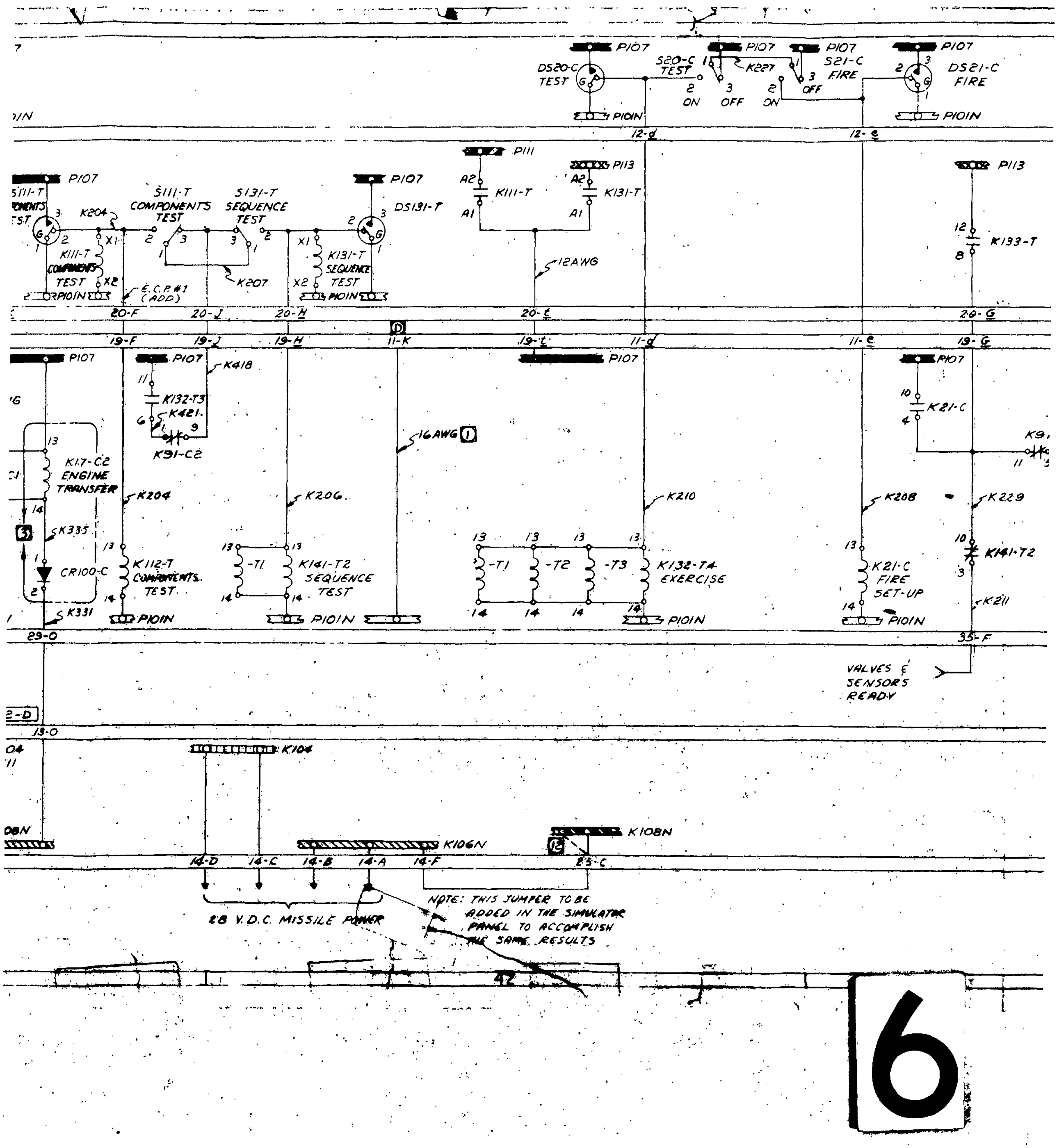
4

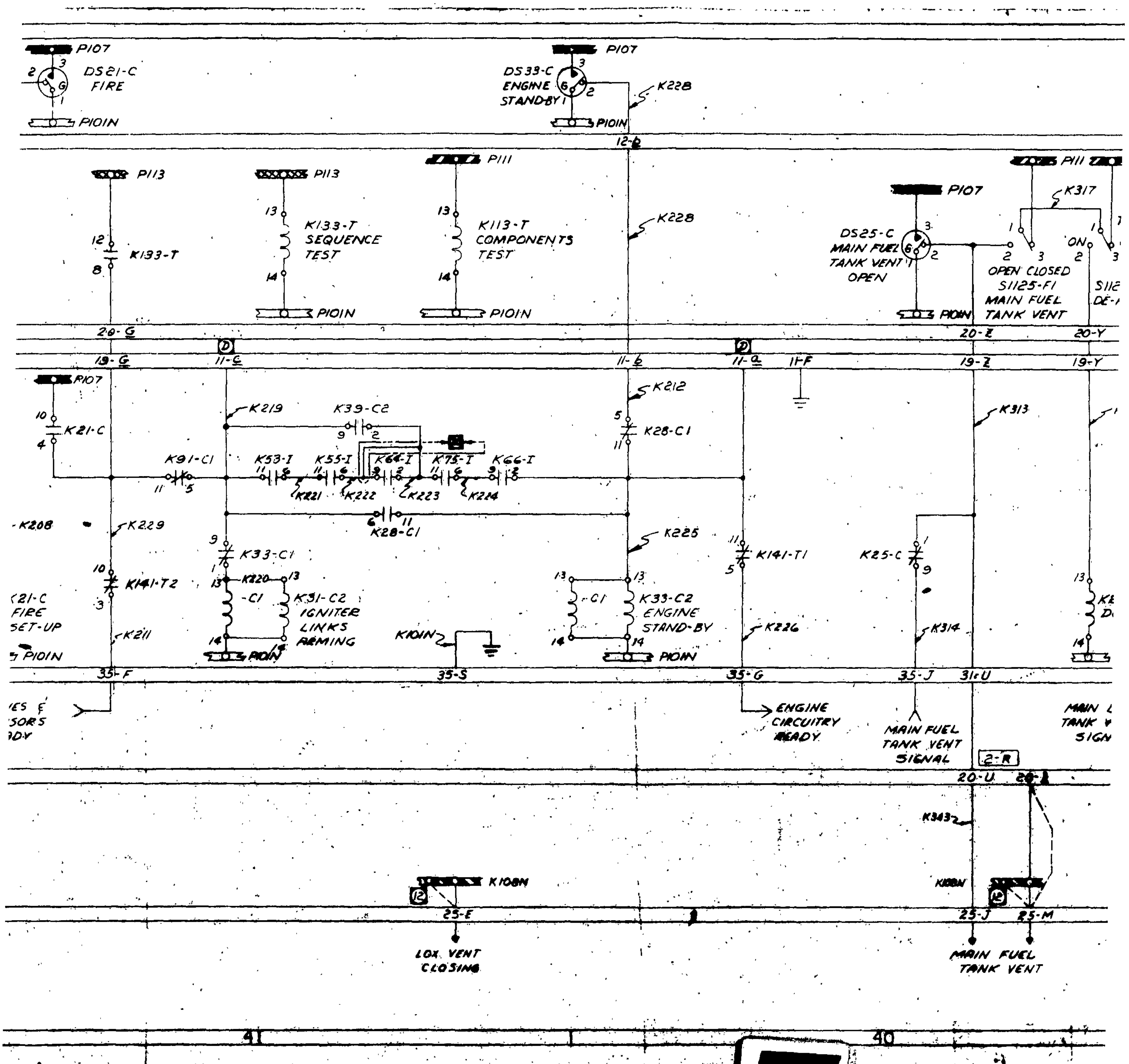


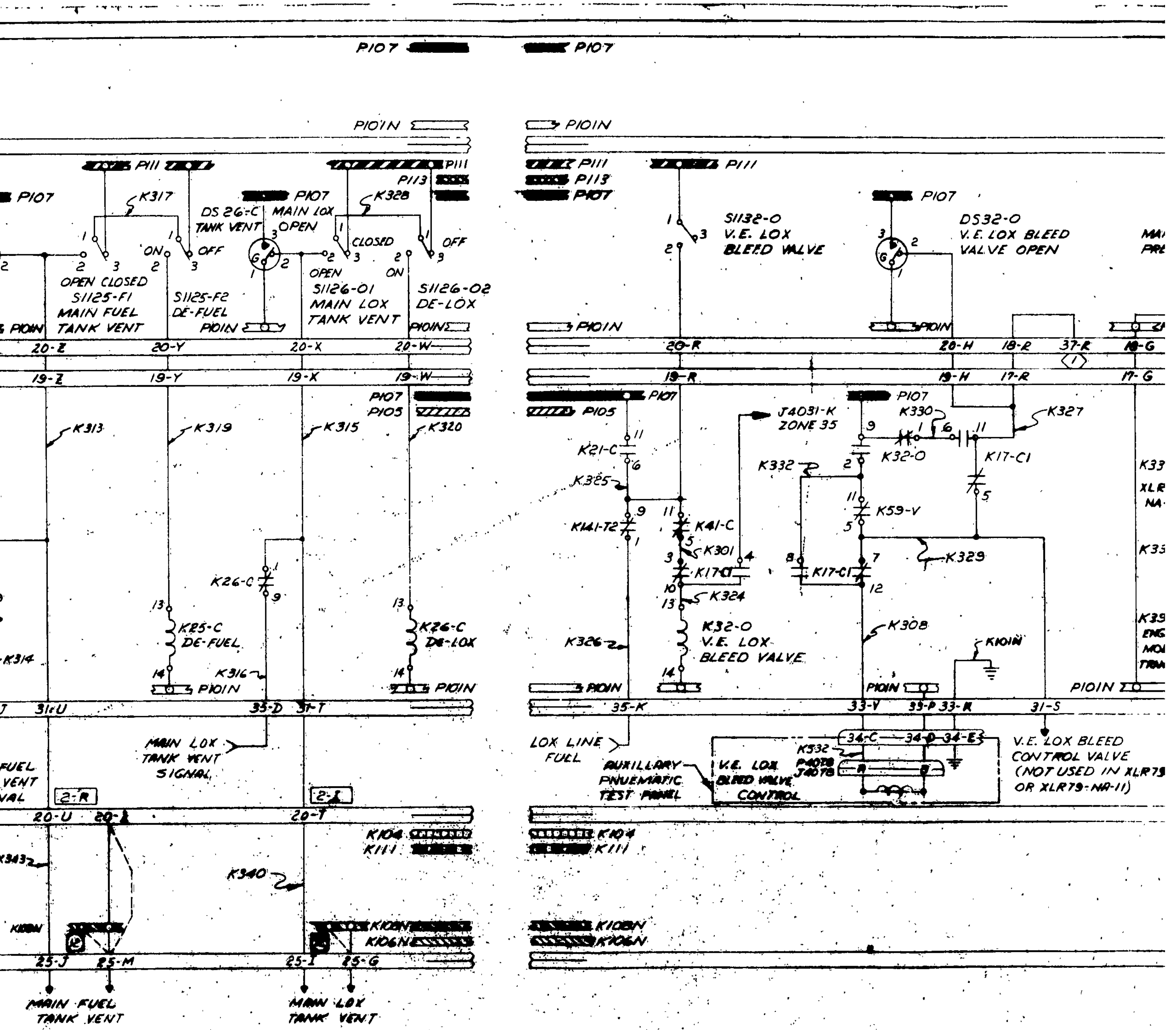
P107
GROUND POWER
S13-C
P101N
(COMPONENT TEST BUS) P111
(SEQUENCE TEST BUS) P113
P107
DS14-C ENGINE HEATERS
DS12-C BLANKET HEATERS
X5C
X5A
P108
20AWG
P103
R14-C 1300 Ω 25 W
R12-C 1300 Ω 25 W
20 AWG
S11-C
GROUND
3 MISSILE
P104
J4009 P4009
P4010 J4010
P107
P105
K101N
P103
P108
16AWG
20AWG
8AWG
20AWG
K11-C
P112
P101N
8AWG
X3A
X3B
X3C
X1N
K101N
12AWG
K14-C
K15-C
12 AWG
X6A
X6B
X4B
X4A
X4C
M12-C1
0-30 AMP
K13-C2
D.C. GROUND POWER
P101N
J4005 P4005
P4006 J4006
MISSILE POWER TO RERB
BLANKET HEATERS
X2N
X4
(REF) 453548
P56
J56
XLR79-NA-11
TURBOPUMP HEATER
LOX VALVE HEATER
TURBOPUMP HEATER
TURBINE OVERSPEED TRIP HEATER
LOX SW


GROUND POWER
S13-C
P107
DS13-C
GROUND POWER
DS15-C
MISSILE POWER
P10N
P111
P113
P108
20 AWG
P103
20 AWG
S131-C
GROUND POWER SEQUENCE TEST
16 AWG
DS111-T
COMPONENTS TEST
K204
S111-T
COMPONENT TEST
K111-T
COMPONENTS TEST
P101 N
E.C.P.#1 (ADD)
P106
K132-T3
K205
K202
K132-T1
P109
K13-C2
K91-C1
K201
16 AWG
K81-C1
K203
K16-C
D.C. MISSILE POWER
K15-C
BLANKET HEATERS THERMOSTAT
K81-C2
P115
K14-C
ENGINE HEATERS POWER
K13-C2
D.C. GROUND POWER
P105
16 AWG
12 AWG
K81-C3
K110
K61-C1
K61-C2
K116
K13-C1
CR96C-1
ZONE 19
P104
12 AWG
K307
K17-C2
ENGINE TRANSFER
K335
CR100-C
K331
K112-T
COMPONENT TEST
K104
K111
K108N
V305
X4
X2N
X11
X12
X5
BLANK HEATER THERMOSTAT
XLR79-NA-11
P37
J37
S24-0
S25-0
S23-0
TURBINE TRIP HEATER
OVERSPEED
LOX VALVE POS. SW. HEATER
PNEUMATIC REGULATOR HEATER
IGNITER FUEL VALVE HEATER
44
43

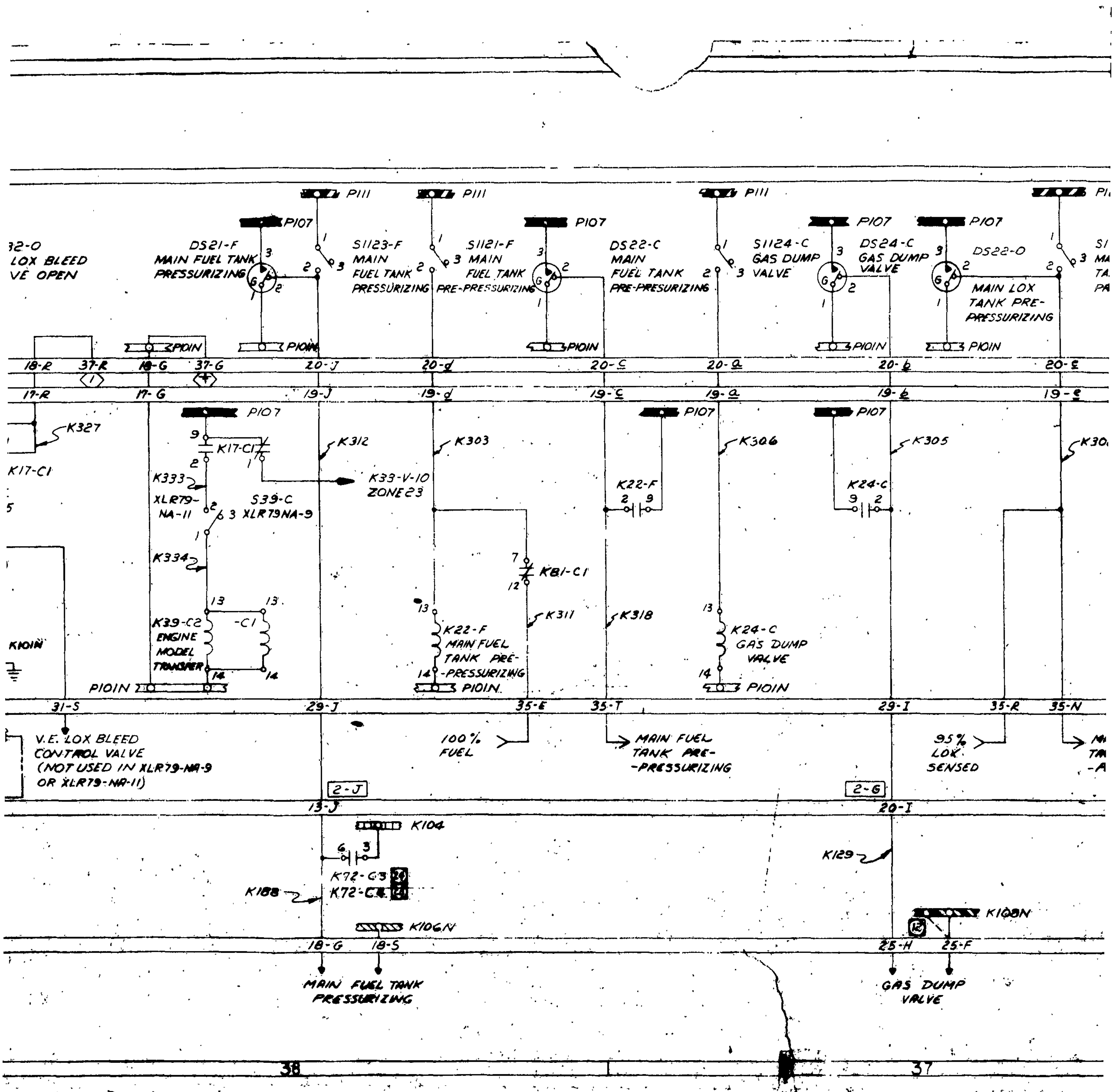
5


P107
DS20-C TEST
S20-C TEST
K227
2 ON
3 OFF
S21-C FIRE
DS21-C FIRE
P101N
12-d
12-e
P111
P113
K111-T
K131-T
S111-T COMPONENTS TEST
S131-T SEQUENCE TEST
DS131-T
K204
K207
K111-T COMPONENTS TEST
K131-T SEQUENCE TEST
E.C.P. #1 (ADD)
12AWG
K133-T
20-F
20-J
20-H
20-t
20-G
19-F
19-J
19-H
11-K
19-t
11-d
11-e
19-G
K418
K132-T3
K421
K91-C2
16AWG
K17-C2 ENGINE TRANSFER
K335
CR100-C
K331
K112-T COMPONENTS TEST
K206
K141-T2 SEQUENCE TEST
K210
K132-T4 EXERCISE
K208
K21-C FIRE SET-UP
K21-C
K229
K141-T2
K211
29-O
35-F
VALVES & SENSOR'S READY
13-O
K104
K106N
K108N
14-D
14-C
14-B
14-A
14-F
25-C
28 V.D.C. MISSILE POWER
NOTE: THIS JUMPER TO BE ADDED IN THE SIMULATOR PANEL TO ACCOMPLISH THE SAME RESULTS
42
6

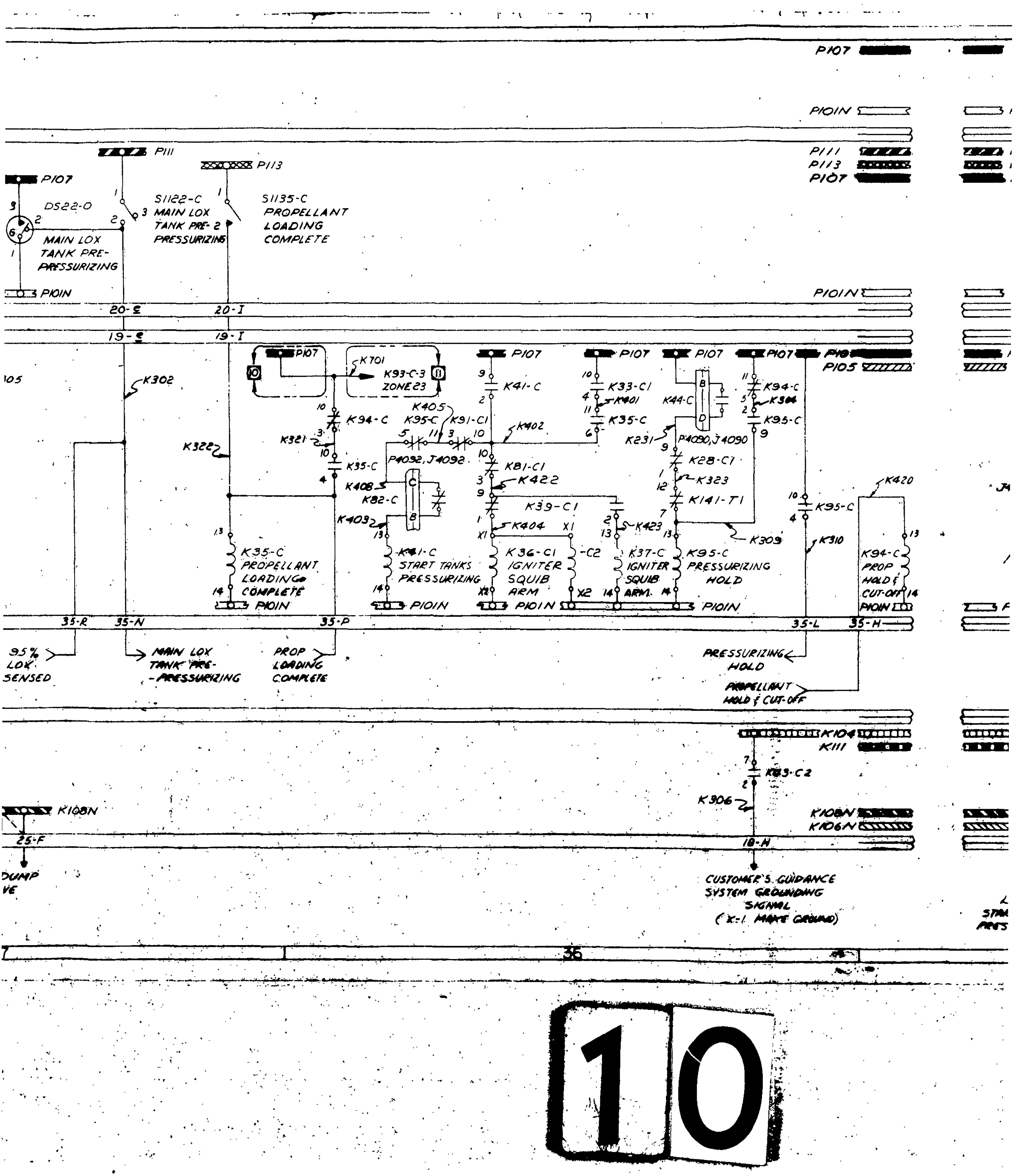

P107
DS21-C
FIRE
P10N
P107
DS33-C
ENGINE
STAND-BY
K228
P10N
12-b
P113
K133-T
P113
K133-T
SEQUENCE
TEST
P111
K113-T
COMPONENTS
TEST
P10N
P107
DS25-C
MAIN FUEL
TANK VENT
OPEN
P111
K317
OPEN CLOSED
S1125-F1
MAIN FUEL
TANK VENT
ON
20-G
19-G
11-G
11-b
11-a
11-F
20-Z
19-Z
20-Y
19-Y
P107
K21-C
K219
K39-C2
K91-C1
K53-I
K55-I
K64-I
K75-I
K66-I
K221
K222
K223
K224
K28-C1
K212
K208
K229
K225
K313
K33-C1
K141-T2
K220
K31-C2
IGNITER
LINKS
ARMING
K33-C2
ENGINE
STAND-BY
K141-T1
K25-C
K21-C
FIRE
SET-UP
K211
K10N
K226
K314
35-F
35-S
35-G
35-J
31-U
ENGINE
CIRCUITRY
READY
MAIN FUEL
TANK VENT
SIGNAL
2-R
20-U
K343
K108N
25-E
25-J
25-M
LOX VENT
CLOSING
MAIN FUEL
TANK VENT
41
40

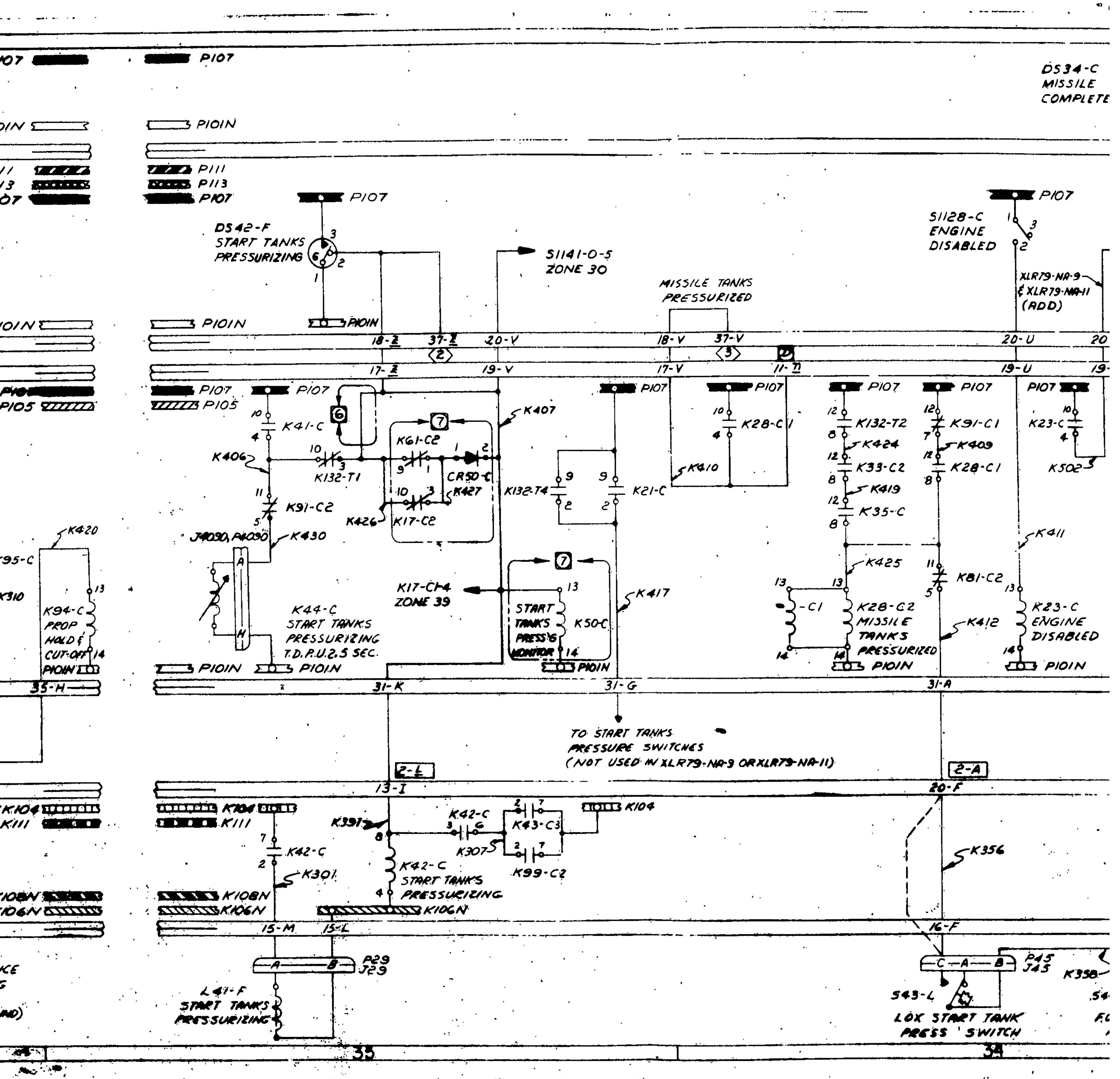


P107
P107
P10IN
P10IN
P111
P111
P113
K317
K328
DS 26-C TANK VENT
MAIN LOX OPEN
OPEN CLOSED
S1125-F1
MAIN FUEL
TANK VENT
S1125-F2
DE-FUEL
S1126-01
MAIN LOX
TANK VENT
S1126-02
DE-LOX
S1132-O
V.E. LOX
BLEED VALVE
DS32-O
V.E. LOX BLEED
VALVE OPEN
K313
K319
K315
K320
K26-C
K25-C
DE-FUEL
K26-C
DE-LOX
K316
K314
J4031-K
ZONE 35
K330
K327
K21-C
K32-O
K17-C1
K332
K325
K59-V
K141-T2
K41-C
K301
K329
K324
K32-O
V.E. LOX
BLEED VALVE
K308
K326
K101N
MAIN LOX
TANK VENT
SIGNAL
LOX LINE
FULL
AUXILLARY
PNUEMATIC
TEST PANEL
V.E. LOX
BLEED VALVE
CONTROL
K332
P4078
J4078
V.E. LOX BLEED
CONTROL VALVE
(NOT USED IN XLR79
OR XLR79-NA-11)
K104
K111
K343
K340
K106N
MAIN FUEL
TANK VENT
MAIN LOX
TANK VENT

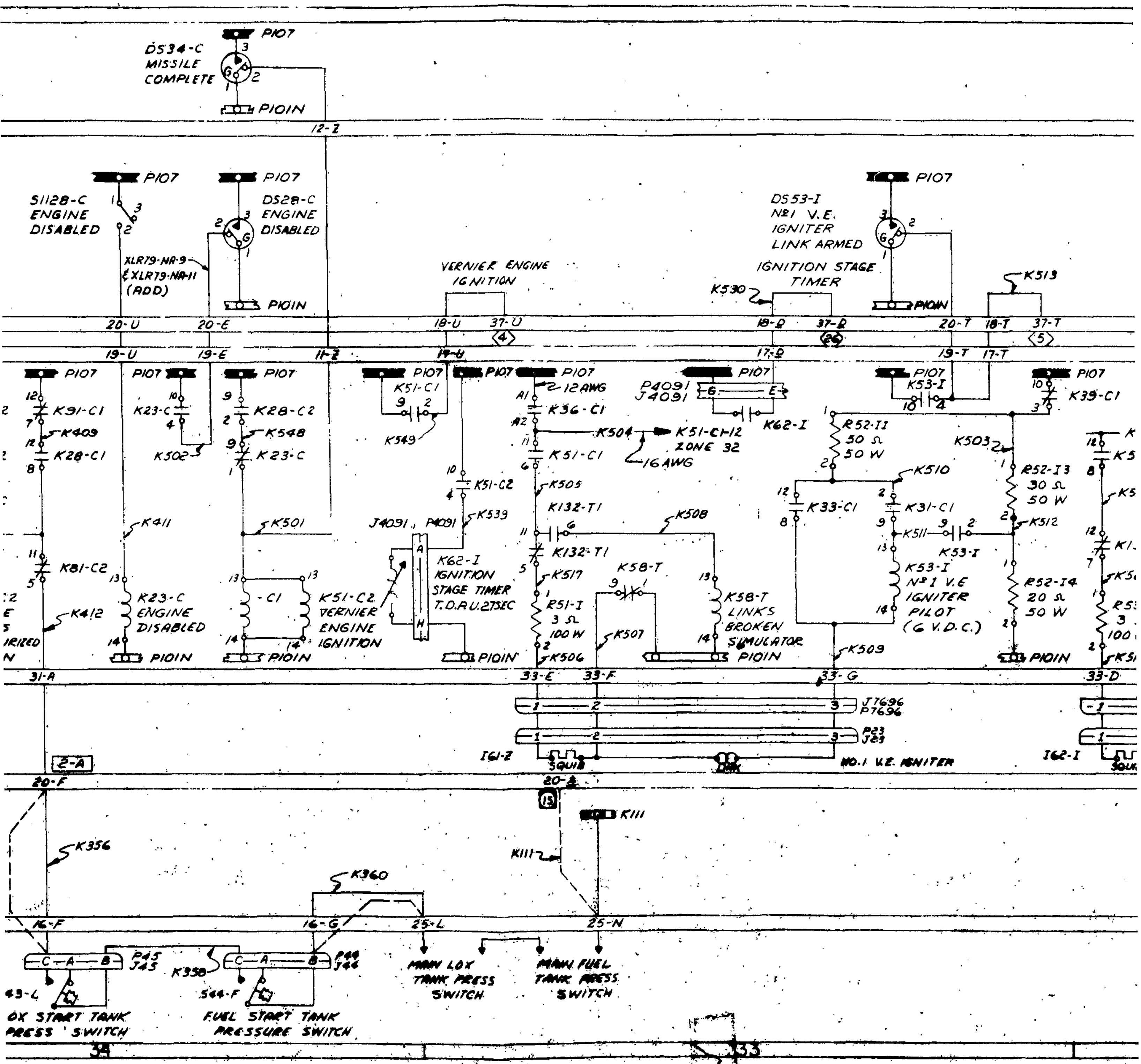

P111
P107
32-O LOX BLEED VE OPEN
DS21-F MAIN FUEL TANK PRESSURIZING
S1123-F MAIN FUEL TANK PRESSURIZING
S1121-F MAIN FUEL TANK PRE-PRESSURIZING
DS22-C MAIN FUEL TANK PRE-PRESSURIZING
S1124-C GAS DUMP VALVE
DS24-C GAS DUMP VALVE
DS22-O MAIN LOX TANK PRE-PRESSURIZING
P10N
18-R
37-R
18-G
37-G
20-J
20-d
20-c
20-a
20-b
20-e
17-R
17-G
19-J
19-d
19-c
19-a
19-b
19-e
K327
K17-C1
K333
XLR79-NA-11
S39-C XLR79NA-9
K334
K39-C2 ENGINE MODEL TRANSFER
K312
K33-V-10 ZONE 23
K303
KB1-C1
K22-F MAIN FUEL TANK PRE-PRESSURIZING
K311
K318
K22-F
K306
K24-C GAS DUMP VALVE
K24-C
K305
K10IN
31-S
29-J
35-E
35-T
29-I
35-R
35-N
V.E. LOX BLEED CONTROL VALVE (NOT USED IN XLR79-NA-9 OR XLR79-NA-11)
100% FUEL
MAIN FUEL TANK PRE-PRESSURIZING
95% LOX SENSED
2-J
2-G
13-J
20-I
K104
K72-G3
K72-C4
K188
K106N
K129
K108N
18-G
18-S
25-H
25-F
MAIN FUEL TANK PRESSURIZING
GAS DUMP VALVE
38
37

9


P107
P10IN
P111
P113
P107
DS22-O
MAIN LOX
TANK PRE-
PRESSURIZING
S1122-C
MAIN LOX
TANK PRE-
PRESSURIZING
S1135-C
PROPELLANT
LOADING
COMPLETE
K302
K322
K701
K93-C-3
ZONE 23
K94-C
K321
K35-C
K405
K95-C
K91-C1
P4092, J4092
K408
K82-C
K403
K41-C
START TANKS
PRESSURIZING
K402
K81-C1
K422
K39-C1
K404
K36-C1
IGNITER
SQUIB
ARM
K33-C1
K401
K35-C
K44-C
P4090, J4090
K231
K28-C1
K323
K141-T1
K423
K37-C
IGNITER
SQUIB
ARM
K95-C
PRESSURIZING
HOLD
K309
K94-C
K304
K95-C
K310
K420
K94-C
PROP
HOLD &
CUT-OFF
P105
K35-C
PROPELLANT
LOADING
COMPLETE
95%
LOX
SENSED
MAIN LOX
TANK PRE-
-PRESSURIZING
PROP
LOADING
COMPLETE
PRESSURIZING
HOLD
PROPELLANT
HOLD & CUT-OFF
K104
K111
K93-C2
K306
K108N
K106N
CUSTOMER'S GUIDANCE
SYSTEM GROUNDING
SIGNAL
(X-1 MAKE GROUND)
DUMP
VE
35
10

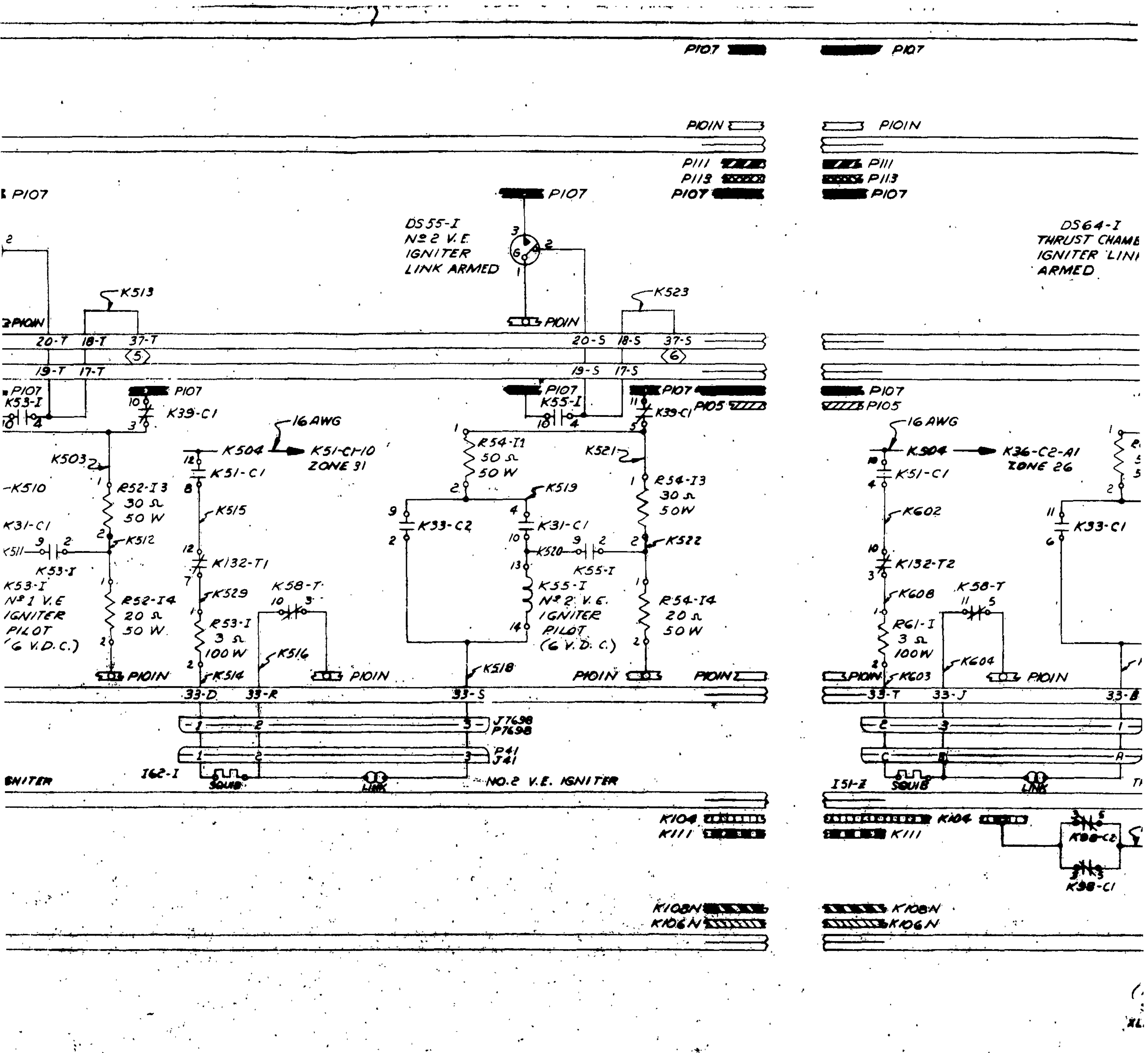


P107
DS34-C
MISSILE
COMPLETE
P10N
P111
P113
P107
DS42-F
START TANKS
PRESSURIZING
S1141-0-5
ZONE 30
MISSILE TANKS
PRESSURIZED
S1128-C
ENGINE
DISABLED
XLR79-NA-9
& XLR79-NA-11
(ADD)
18-Z
37-Z
20-V
18-V
37-V
20-U
17-Z
19-V
17-V
11-n
19-U
P105
K41-C
K406
K132-T1
K61-C2
CR50-C
K407
K427
K426
K17-C2
K91-C2
K430
J4090, P4090
K132-T4
K21-C
K410
K28-C1
K132-T2
K424
K33-C2
K419
K35-C
K425
K91-C1
K409
K28-C1
K81-C2
K23-C
K502
K411
K420
K95-C
K310
K94-C
PROP
HOLD &
CUT-OFF
K44-C
START TANKS
PRESSURIZING
T.D.P.U. 2.5 SEC.
K17-C1-4
ZONE 39
START
TANKS
PRESS'G
MONITOR
K50-C
K417
-C1
K28-C2
MISSILE
TANKS
PRESSURIZED
K412
K23-C
ENGINE
DISABLED
35-H
31-K
31-G
31-A
TO START TANKS
PRESSURE SWITCHES
(NOT USED IN XLR79-NA-9 OR XLR79-NA-11)
2-L
2-A
13-I
20-F
K104
K111
K42-C
K391
K43-C3
K307
K99-C2
K356
K301
K42-C
START TANKS
PRESSURIZING
K108N
K106N
15-M
15-L
16-F
P29
J29
L41-F
START TANKS
PRESSURIZING
P45
J45
K338
S43-L
LOX START TANK
PRESS SWITCH
35
34

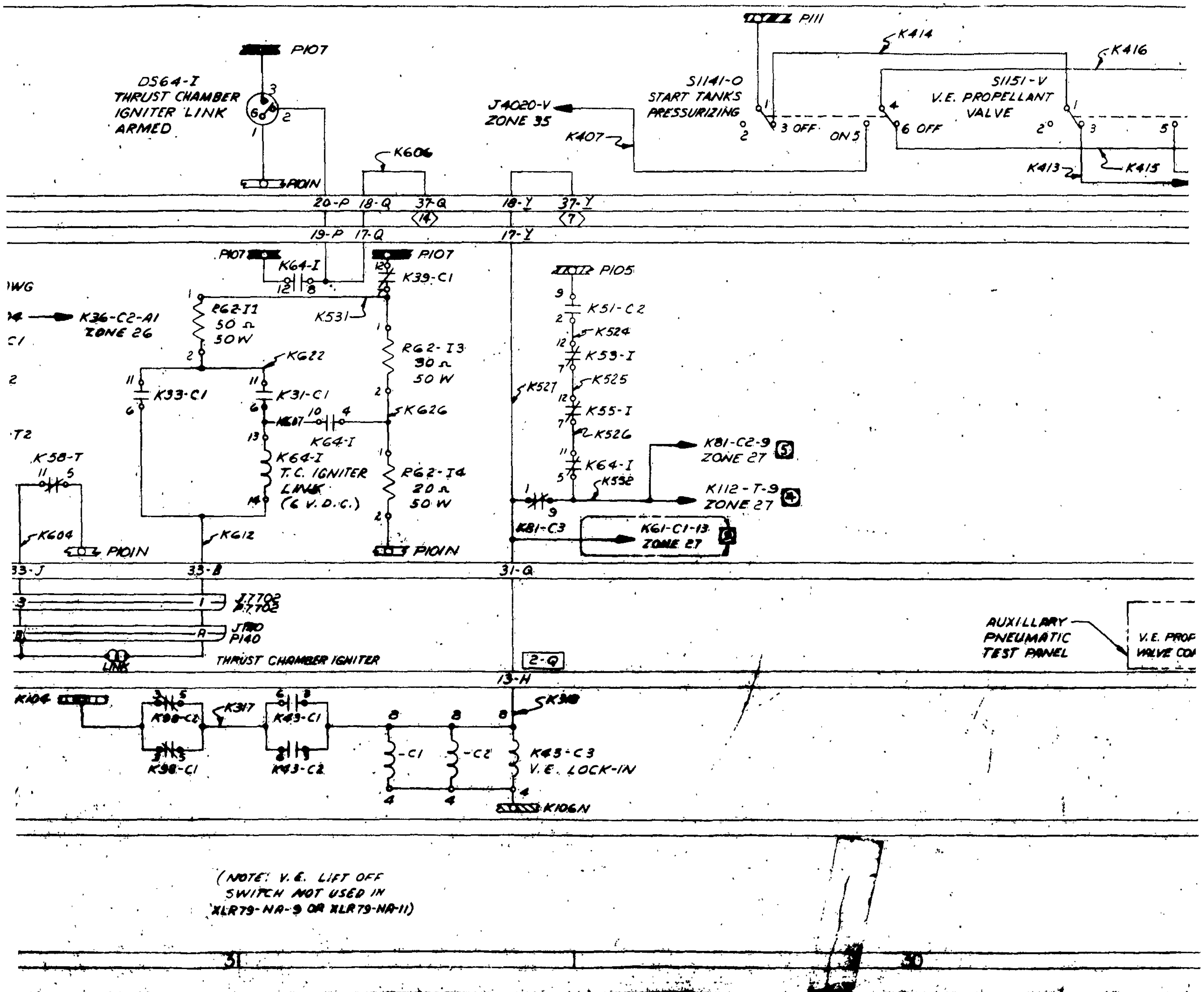


P107
DS34-C MISSILE COMPLETE
P10N
12-Z
S1128-C ENGINE DISABLED
DS28-C ENGINE DISABLED
XLR79-NA-9 & XLR79-NA-11 (ADD)
VERNIER ENGINE IGNITION
DS53-I Nº1 V.E. IGNITER LINK ARMED
IGNITION STAGE TIMER
K530
K513
K91-C1
K409
K28-C1
K23-C
K502
K28-C2
K548
K51-C1
K549
K51-C2
K539
J4091
P4091
K62-I IGNITION STAGE TIMER T.D.R.U. 2.75 SEC
12 AWG
K36-C1
K504
K51-C1-12 ZONE 32
16 AWG
K505
K132-T1
K508
K517
R51-I 3 Ω 100 W
K506
K507
K58-T
K58-T LINKS BROKEN SIMULATOR
K62-I
R52-I1 50 Ω 50 W
K510
K33-C1
K31-C1
K511
K53-I
K53-I Nº1 V.E. IGNITER PILOT (6 V.D.C.)
K503
R52-I3 30 Ω 50 W
K512
R52-I4 20 Ω 50 W
K509
K39-C1
K411
K501
K81-C2
K412
K23-C ENGINE DISABLED
K51-C2 VERNIER ENGINE IGNITION
31-A
33-E
33-F
33-G
33-D
J7696 P7696
P23 J83
I61-Z
SQUIB
NO.1 V.E. IGNITER
I62-I
2-A
20-F
20-B
15
K111
K356
K360
16-F
16-G
25-L
25-N
P45 J45
K358
P44 J44
MAIN LOX TANK PRESS SWITCH
MAIN FUEL TANK PRESS SWITCH
LOX START TANK PRESS SWITCH
FUEL START TANK PRESSURE SWITCH
34
33

12

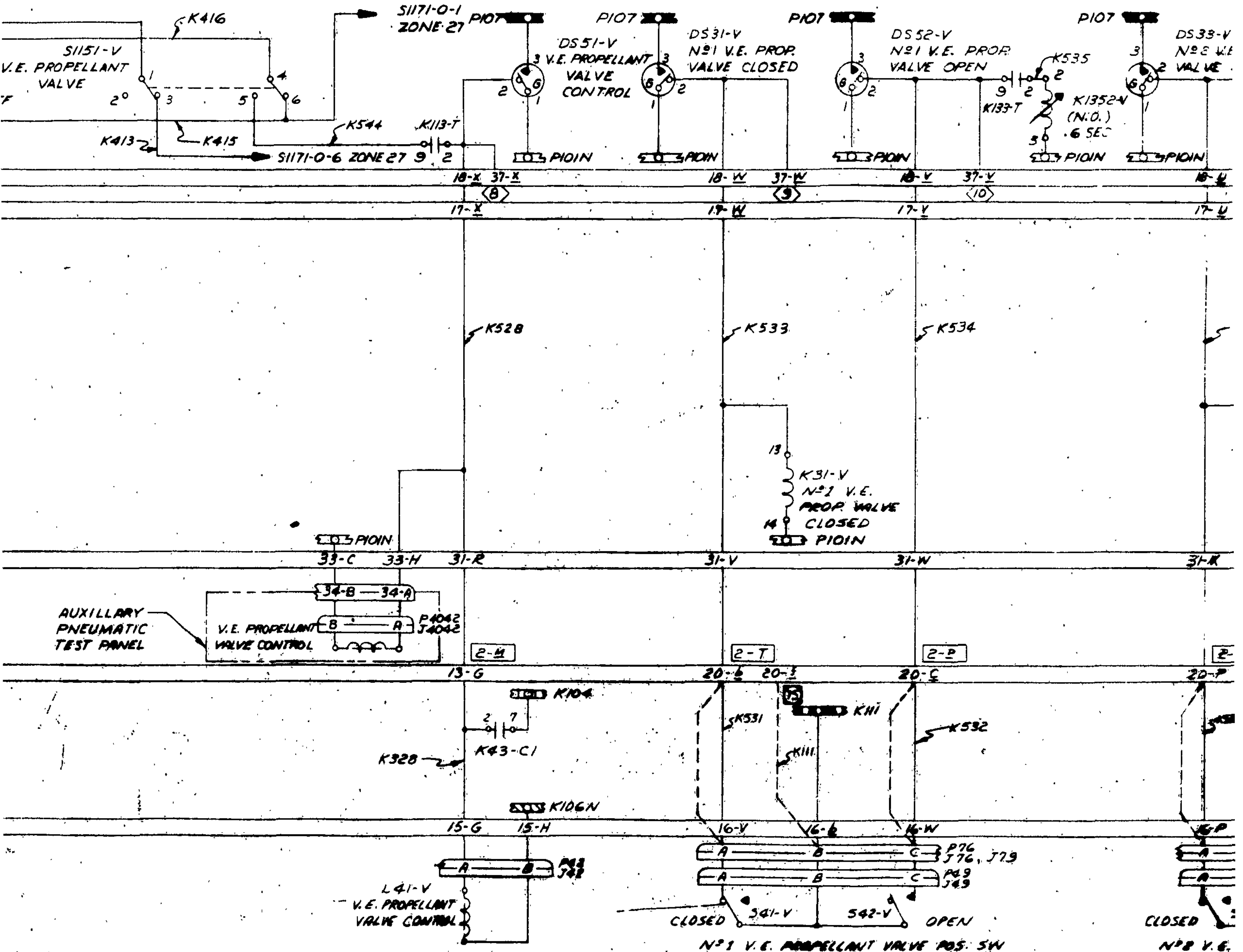

P107
P10N
P111
P113
DS55-I
Nº2 V.E.
IGNITER
LINK ARMED
DS64-I
THRUST CHAMB
IGNITER LINK
ARMED
K513
K523
20-T 18-T 37-T
19-T 17-T
20-S 18-S 37-S
19-S 17-S
K53-I
K39-C1
K55-I
P105
16 AWG
K504
K51-C1-10
ZONE 31
K36-C2-A1
ZONE 26
K503
K510
K51-C1
K31-C1
K511
K512
K515
K519
K521
K522
K520
R52-I3
30 Ω
50 W
R52-I4
20 Ω
50 W
R54-I1
50 Ω
50 W
R54-I3
30 Ω
50 W
R54-I4
20 Ω
50 W
K53-I
Nº1 V.E.
IGNITER
PILOT
(6 V.D.C.)
K55-I
Nº2 V.E.
IGNITER
PILOT
(6 V.D.C.)
K132-T1
K132-T2
K529
K58-T
R53-I
3 Ω
100 W
K516
K514
K518
K33-C2
K33-C1
K602
K608
R61-I
3 Ω
100 W
K604
K603
33-D
33-R
33-S
33-T
33-J
J7698
P7698
P41
J41
I62-I
SQUIB
LINK
NO.2 V.E. IGNITER
I51-I
K104
K111
K98-C2
K98-C1
K108N
K106N

13



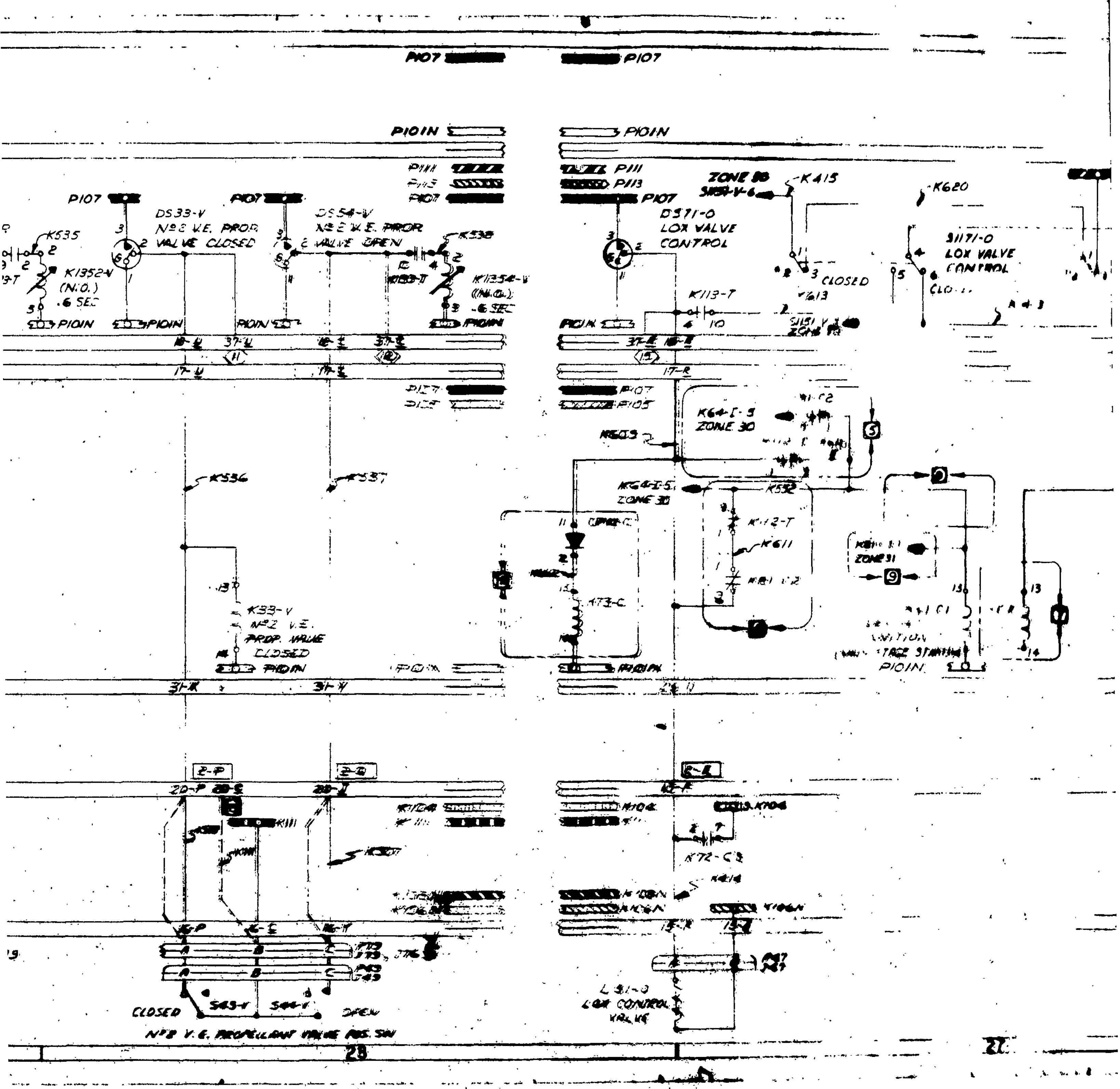
P107
DS64-I THRUST CHAMBER IGNITER LINK ARMED
J4020-V ZONE 35
S1141-O START TANKS PRESSURIZING
S1151-V V.E. PROPELLANT VALVE
P111
K414
K416
K606
K407
K413
K415
P105
R62-I1 50 Ω 50W
R62-I3 30 Ω 50 W
R62-I4 20 Ω 50 W
K64-I T.C. IGNITER LINK (6 V.D.C.)
K81-C2-9 ZONE 27
K112-T-9 ZONE 27
K61-C1-13 ZONE 27
K36-C2-A1 ZONE 26
THRUST CHAMBER IGNITER
AUXILLARY PNEUMATIC TEST PANEL
K43-C3 V.E. LOCK-IN
K106N
(NOTE: V.E. LIFT OFF SWITCH NOT USED IN XLR79-NA-9 OR XLR79-NA-11)
31
30

14

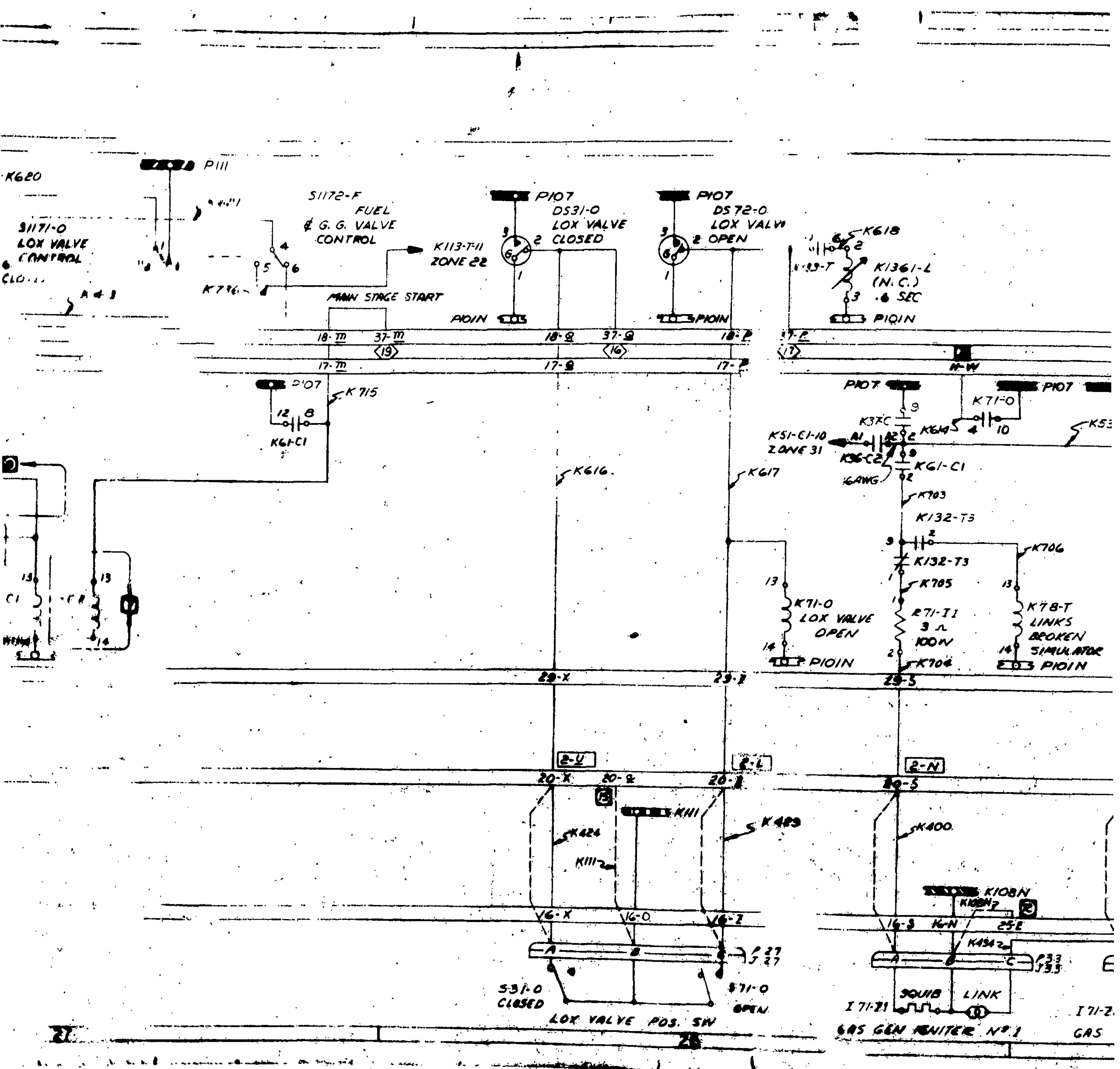


K416
S1151-V
V.E. PROPELLANT
VALVE
K413
K415
K544
K113-T
S1171-O-1
ZONE 27
S1171-O-6 ZONE 27
P107
DS51-V
V.E. PROPELLANT
VALVE
CONTROL
DS31-V
Nº1 V.E. PROP.
VALVE CLOSED
DS52-V
Nº1 V.E. PROP.
VALVE OPEN
K535
K133-T
K1352-V
(N.O.)
.6 SEC
P101N
18-X
37-X
17-X
18-W
37-W
17-W
18-V
37-V
17-V
K528
K533
K534
K31-V
Nº1 V.E.
PROP. VALVE
CLOSED
33-C
33-H
31-R
31-V
31-W
AUXILLARY
PNEUMATIC
TEST PANEL
V.E. PROPELLANT
VALVE CONTROL
34-B
34-A
P4042
J4042
2-T
2-P
13-G
20-C
K104
K43-C1
K328
K531
K111
K532
K106N
15-G
15-H
16-V
16-W
L41-V
V.E. PROPELLANT
VALVE CONTROL
P76
J76, J79
P49
J49
S41-V
S42-V
CLOSED
OPEN
Nº1 V.E. PROPELLANT VALVE POS. SW

15

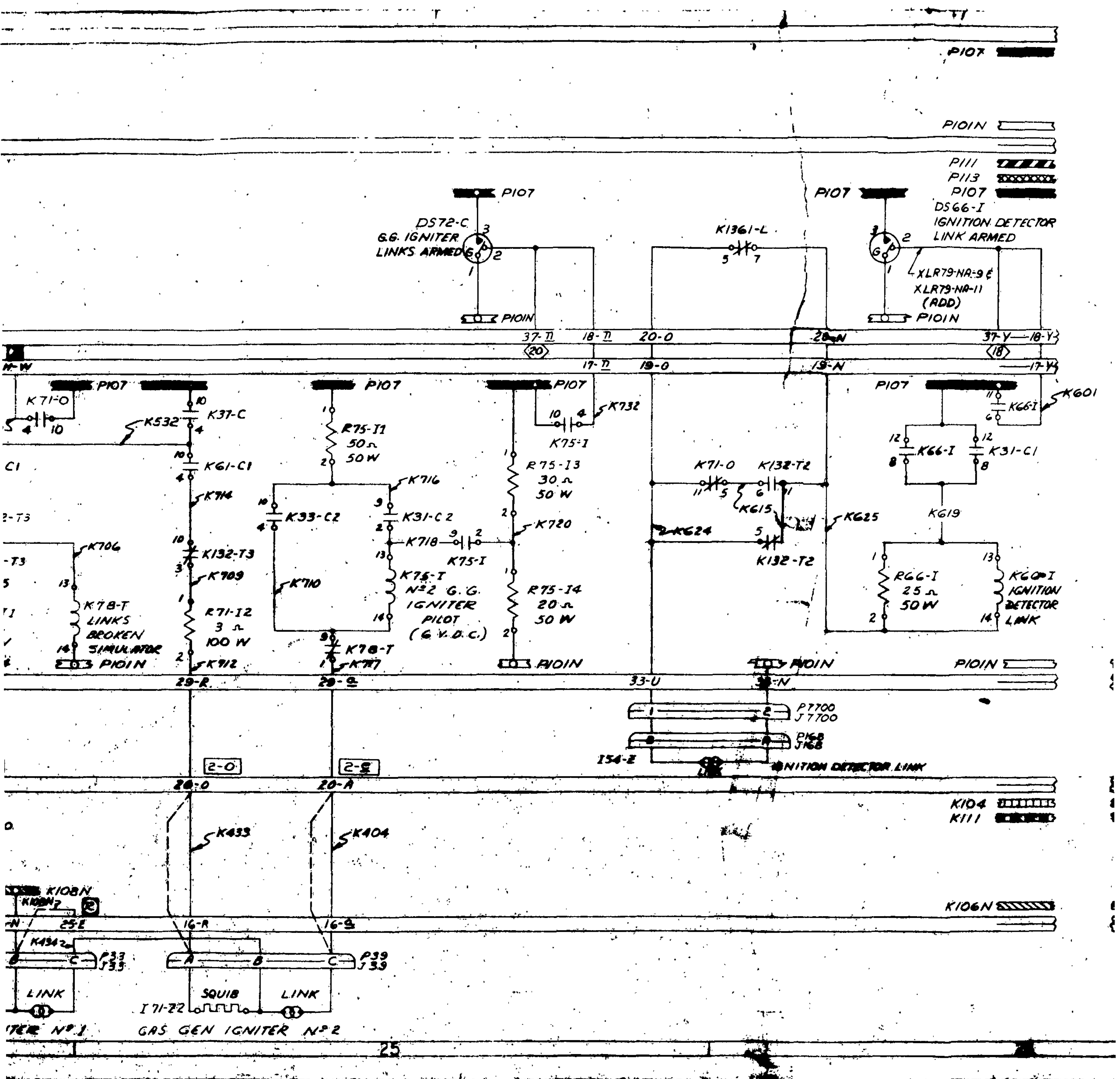

P107
P107
P10N
P10N
P111
P113
P107
DS33-V
Nº2 V.E. PROP.
VALVE CLOSED
DS54-V
Nº2 V.E. PROP.
VALVE OPEN
DS71-0
LOX VALVE
CONTROL
ZONE 30
K415
K620
K535
K1352-V
(N.O.)
.6 SEC
K538
K1354-V
(N.O.)
.6 SEC
S1171-O
LOX VALVE
CONTROL
CLOSED
K113-T
K64-I-5
ZONE 30
K536
K537
K532
K611
K72-C
ZONE 31
K33-V
Nº2 V.E.
PROP. VALVE
CLOSED
K104
K106
K414
K72-C3
CLOSED
S43-V
S44-V
OPEN
Nº2 V.E. PROPELLANT VALVE POS. SW
L31-0
LOX CONTROL
VALVE
28
27

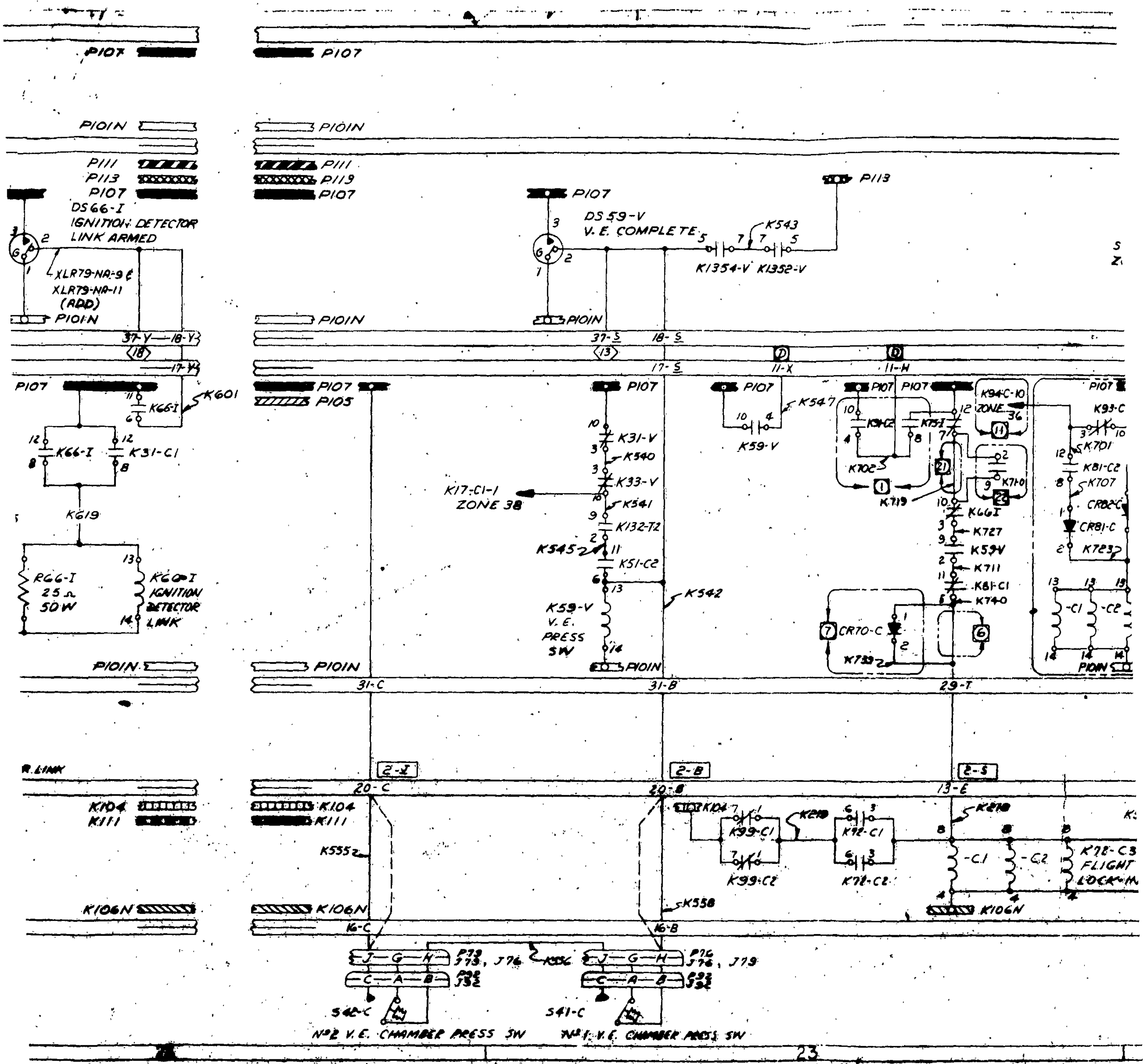
16



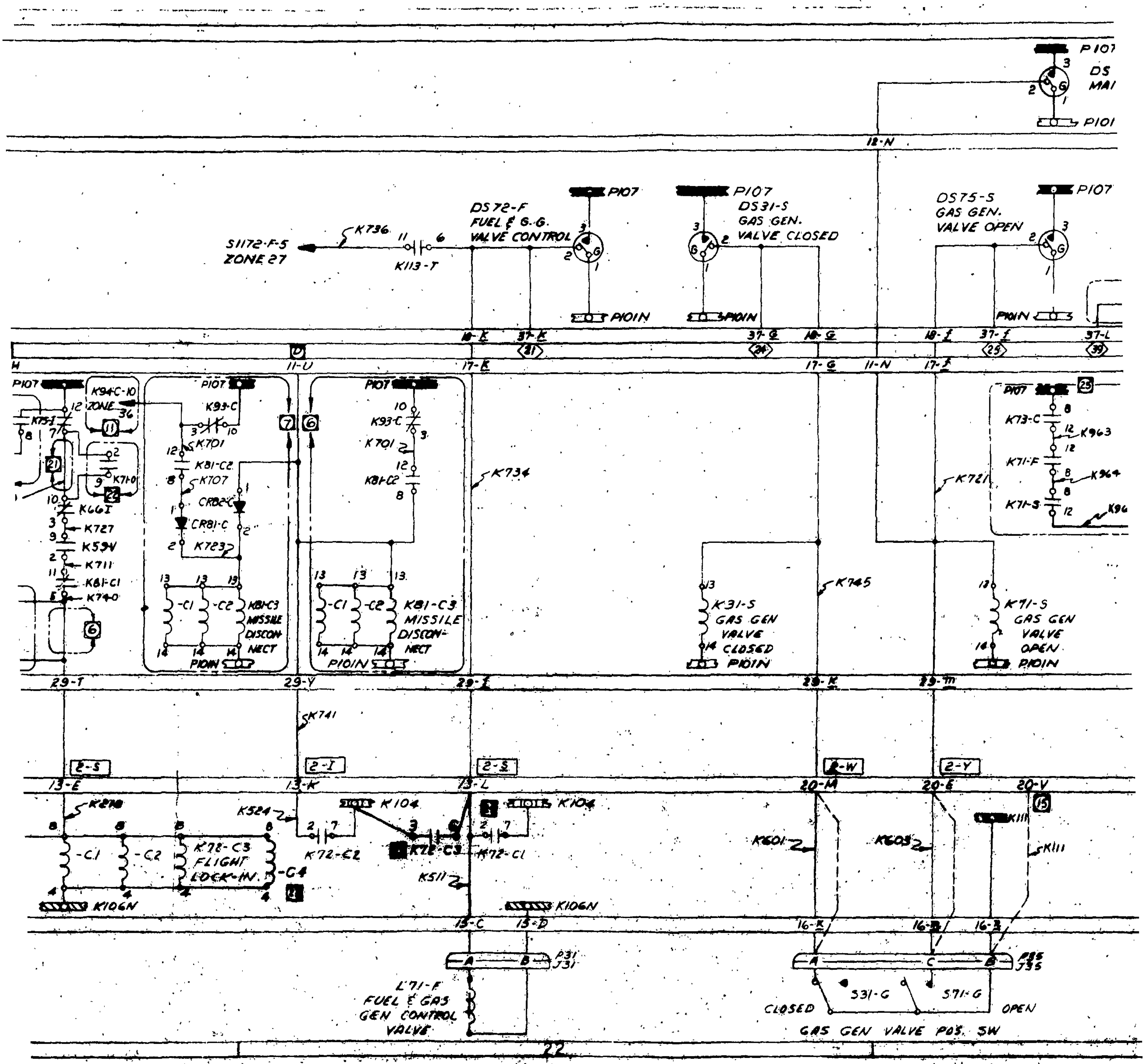
K620
P111
S1171-O
LOX VALVE
CONTROL
S1172-F
FUEL
& G. G. VALVE
CONTROL
K113-T-11
ZONE 22
K716
MAIN STAGE START
P107
DS31-O
LOX VALVE
CLOSED
PIOIN
P107
DS 72-O
LOX VALVE
OPEN
K618
K1361-L
(N.C.)
.6 SEC
PIOIN
18-M
37-M
17-M
18-Q
37-Q
17-Q
18-P
37-P
17-P
N-W
P107
K715
K61-C1
K616
K617
P107
K71-O
K51-C1-10
ZONE 31
K36-C2
K61-C1
16AWG
K703
K132-T3
K706
K705
K71-O
LOX VALVE
OPEN
PIOIN
R71-T1
3 Ω
100W
K704
K78-T
LINKS
BROKEN
SIMULATOR
PIOIN
29-X
29-Z
29-S
2-U
2-L
2-N
20-X
20-Q
20-Z
20-S
K424
K111
K489
K400
K108N
16-X
16-O
16-Z
16-S
16-N
25-E
K434
P27
J27
P33
J33
S31-O
CLOSED
S71-O
OPEN
LOX VALVE POS. SW
SQUIB
LINK
I 71-Z1
GAS GEN IGNITER Nº 1
27
28

17

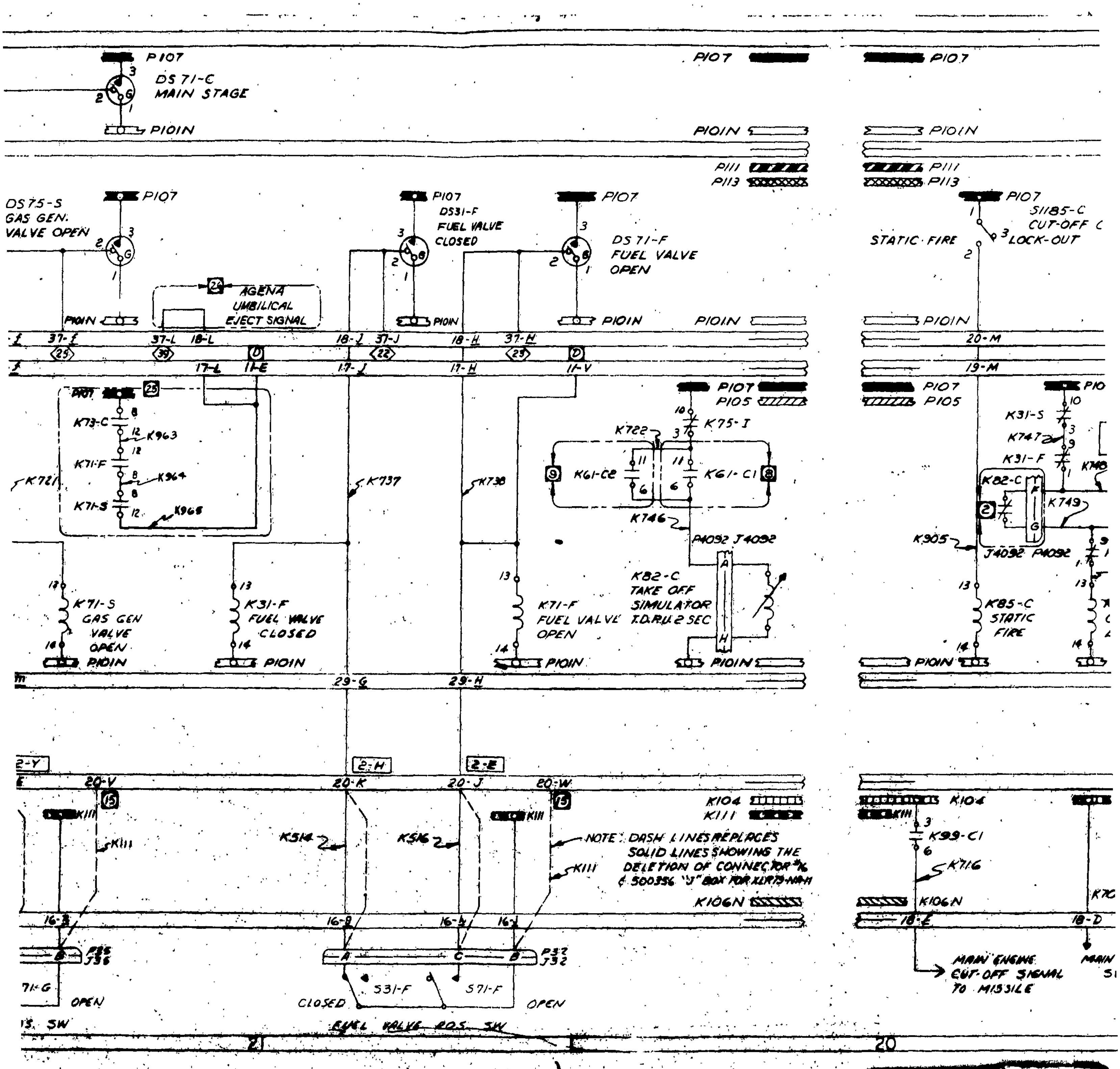

P107
P101N
P111
P113
P107
DS66-I
IGNITION DETECTOR
LINK ARMED
DS72-C
G.G. IGNITER
LINKS ARMED
K1361-L
XLR79-NA-9 ¢
XLR79-NA-11
(ADD)
37-T1
18-T1
20-O
20-N
37-Y
18-Y
17-T1
19-O
19-N
17-Y
K71-O
K37-C
K532
K61-C1
K714
K132-T3
K709
R71-I2
3 Ω
100 W
K712
K706
K78-T
LINKS
BROKEN
SIMULATOR
R75-I1
50 Ω
50 W
K716
K33-C2
K31-C2
K718
K75-I
K710
K75-T
Nº2 G.G.
IGNITER
PILOT
(6 V.D.C.)
K78-T
K717
K732
R75-I3
30 Ω
50 W
K720
R75-I4
20 Ω
50 W
K71-O
K132-T2
K615
K624
K625
K601
K66-I
K31-C1
K619
R66-I
25 Ω
50 W
K60-I
IGNITION
DETECTOR
LINK
29-R
29-Q
33-U
33-N
P7700
J7700
P168
J168
154-Z
IGNITION DETECTOR LINK
2-O
2-Q
20-O
20-A
K104
K111
K433
K404
K108N
25-E
K434
16-R
16-Q
P33
J33
P39
J39
K106N
LINK
SQUIB
LINK
I 71-22
GAS GEN IGNITER Nº 2
25



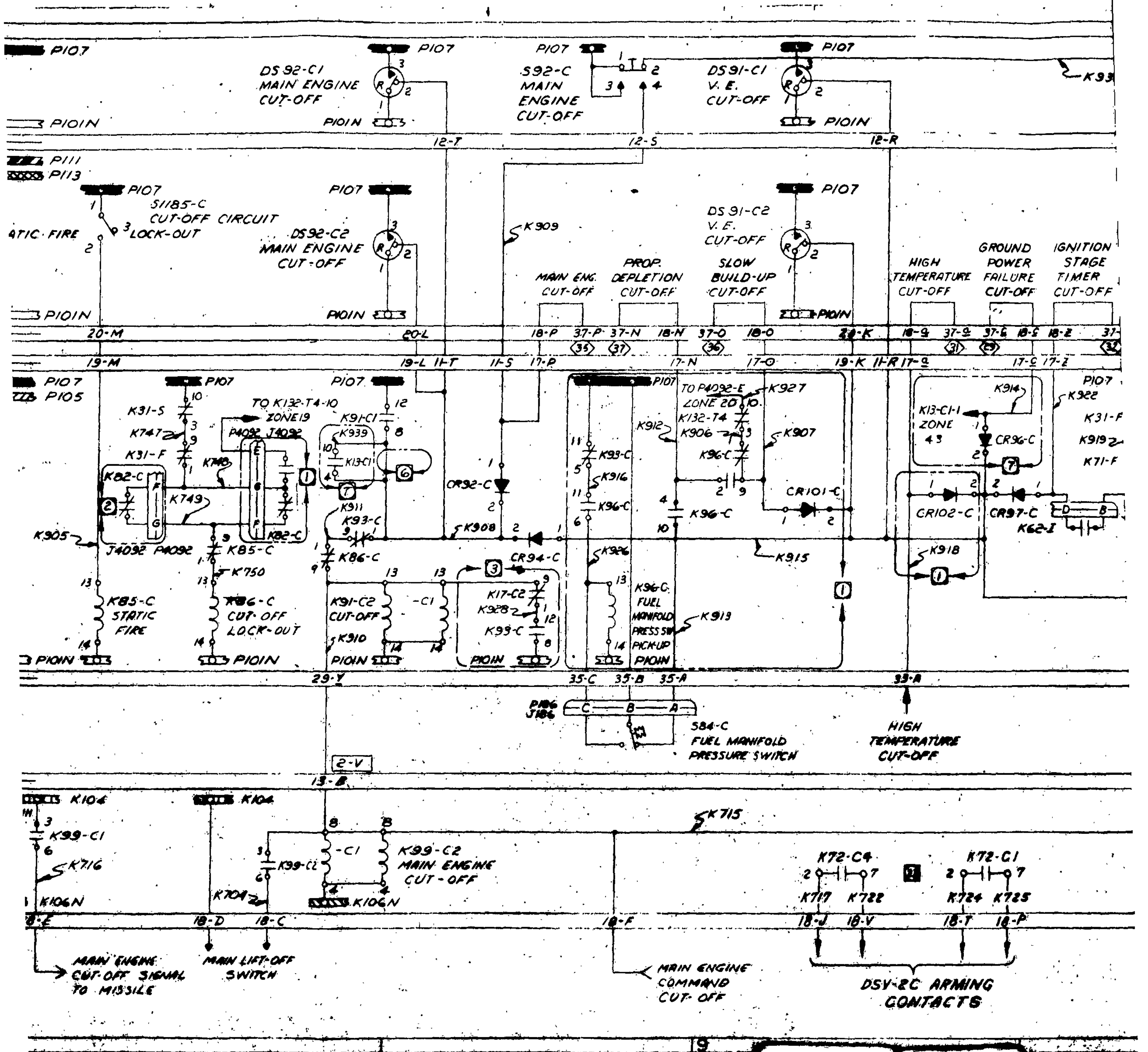
P107
P10N
P111
P113
DS66-I
IGNITION DETECTOR
LINK ARMED
XLR79-NA-9
XLR79-NA-11
(ADD)
DS 59-V
V. E. COMPLETE
K543
K1354-V
K1352-V
37-Y
18-Y
17-Y
37-S
18-S
17-S
11-X
11-H
K601
K66-I
K31-C1
K619
RG6-I
25 Ω
50 W
K60-I
IGNITION
DETECTOR
LINK
P105
K31-V
K540
K33-V
K17-C1-1
ZONE 38
K541
K132-T2
K545
K51-C2
K542
K59-V
V. E.
PRESS
SW
K547
K94-C2
K751
K702
K719
K94C-10
ZONE
36
K710
K66I
K727
K711
K81-C1
K740
CR70-C
K739
K93-C
K701
K81-C2
K707
CR82-C
CR81-C
K723
31-C
31-B
29-T
2-B
2-S
20-C
20-B
13-E
K104
K111
K555
K99-C1
K99-C2
K72-C1
K72-C2
K78-C3
FLIGHT
LOCK
K106N
K558
16-C
16-B
J76
J79
S42-C
S41-C
Nº2 V.E. CHAMBER PRESS SW
Nº1 V.E. CHAMBER PRESS SW
23

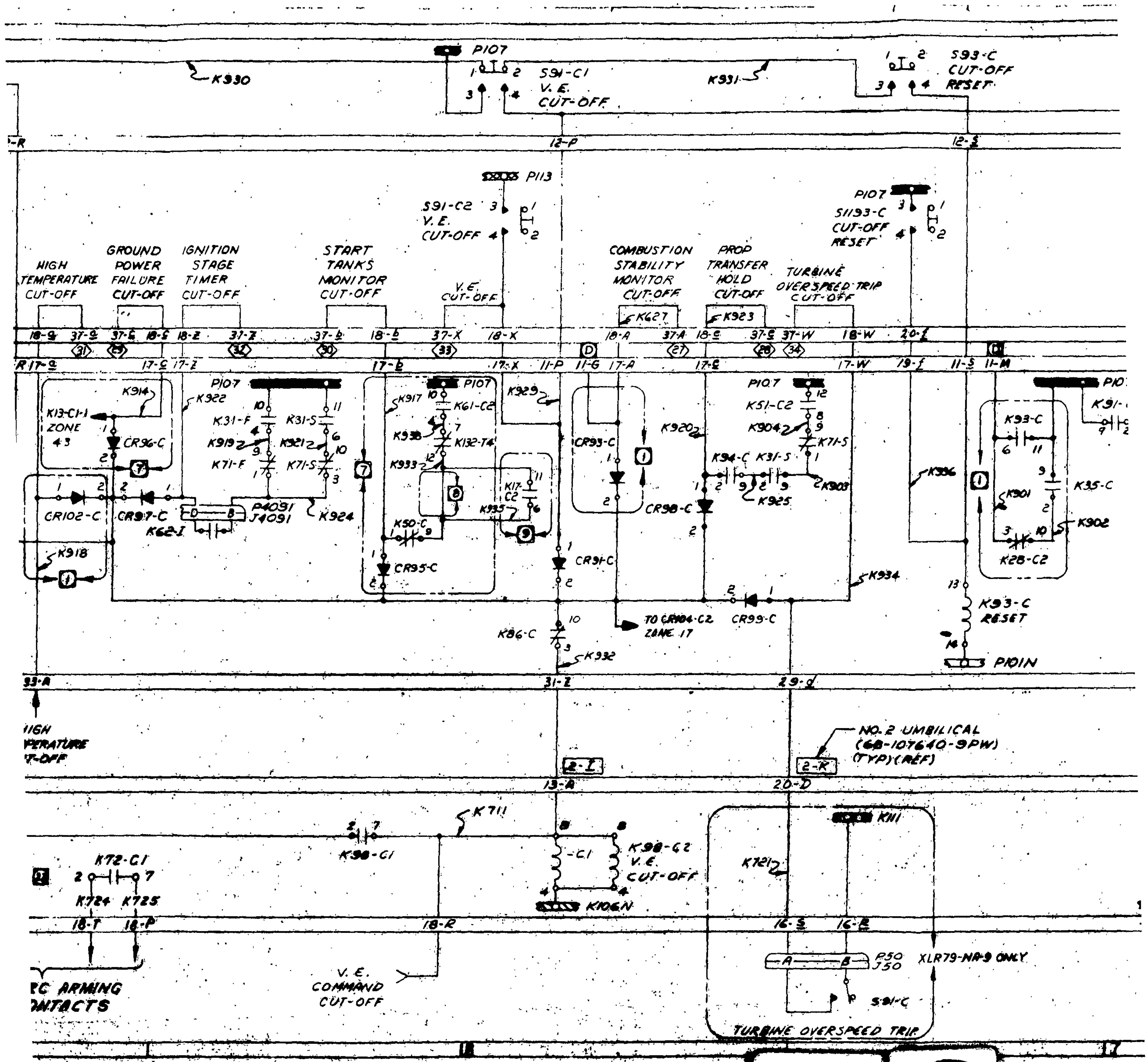

P107
DS
MAI
P101
12-N
DS72-F
FUEL & G.G.
VALVE CONTROL
P107
DS31-S
GAS GEN.
VALVE CLOSED
DS75-S
GAS GEN.
VALVE OPEN
S1172-F-5
ZONE 27
K736
K113-T
P101N
11-U
17-E
17-G
11-N
17-F
K94C-10
ZONE 36
K93-C
K701
K81-C2
K707
CR82-C
CR81-C
K723
K66I
K727
K59V
K711
K81-C1
K740
K81-C3
MISSILE
DISCON-
NECT
K734
K73-C
K963
K71-F
K964
K71-S
K721
K31-S
GAS GEN
VALVE
CLOSED
K745
K71-S
GAS GEN
VALVE
OPEN
29-T
29-Y
K741
13-E
13-K
13-L
20-M
20-E
20-V
K524
K104
K72-C2
K72-C3
K72-C1
K78-C3
FLIGHT
LOCK-IN
K511
K106N
K601
K605
K111
13-C
13-D
16-K
P31
J31
L71-F
FUEL & GAS
GEN CONTROL
VALVE
S31-G
S71-G
CLOSED
OPEN
GAS GEN VALVE POS. SW
22

20


P107
DS 71-C
MAIN STAGE
PIOIN
P111
P113
DS 75-S
GAS GEN.
VALVE OPEN
AGENA
UMBILICAL
EJECT SIGNAL
DS31-F
FUEL VALVE
CLOSED
DS 71-F
FUEL VALVE
OPEN
STATIC FIRE
S1185-C
CUT-OFF
LOCK-OUT
37-L
18-L
11-E
18-J
37-J
17-J
18-H
37-H
17-H
11-V
20-M
19-M
P105
K73-C
K963
K71-F
K964
K71-S
K965
K721
K737
K738
K722
K75-I
K61-C2
K61-C1
K746
P4092 J4092
K82-C
TAKE OFF
SIMULATOR
T.D.P.U. 2 SEC
K31-S
K747
K31-F
K749
K905
J4092 P4092
K71-S
GAS GEN
VALVE
OPEN
K31-F
FUEL VALVE
CLOSED
K71-F
FUEL VALVE
OPEN
K85-C
STATIC
FIRE
29-G
29-H
2-Y
2-H
2-E
20-V
20-K
20-J
20-W
K104
K111
K514
K516
NOTE: DASH LINES REPLACES
SOLID LINES SHOWING THE
DELETION OF CONNECTOR #16
& 500356 "J" BOX FOR XLR73-NA-H
K106N
K99-C1
K716
16-B
16-A
18-E
18-D
S31-F
S71-F
CLOSED
OPEN
P32
J32
MAIN ENGINE
CUT-OFF SIGNAL
TO MISSILE
FUEL VALVE POS. SW
21
20

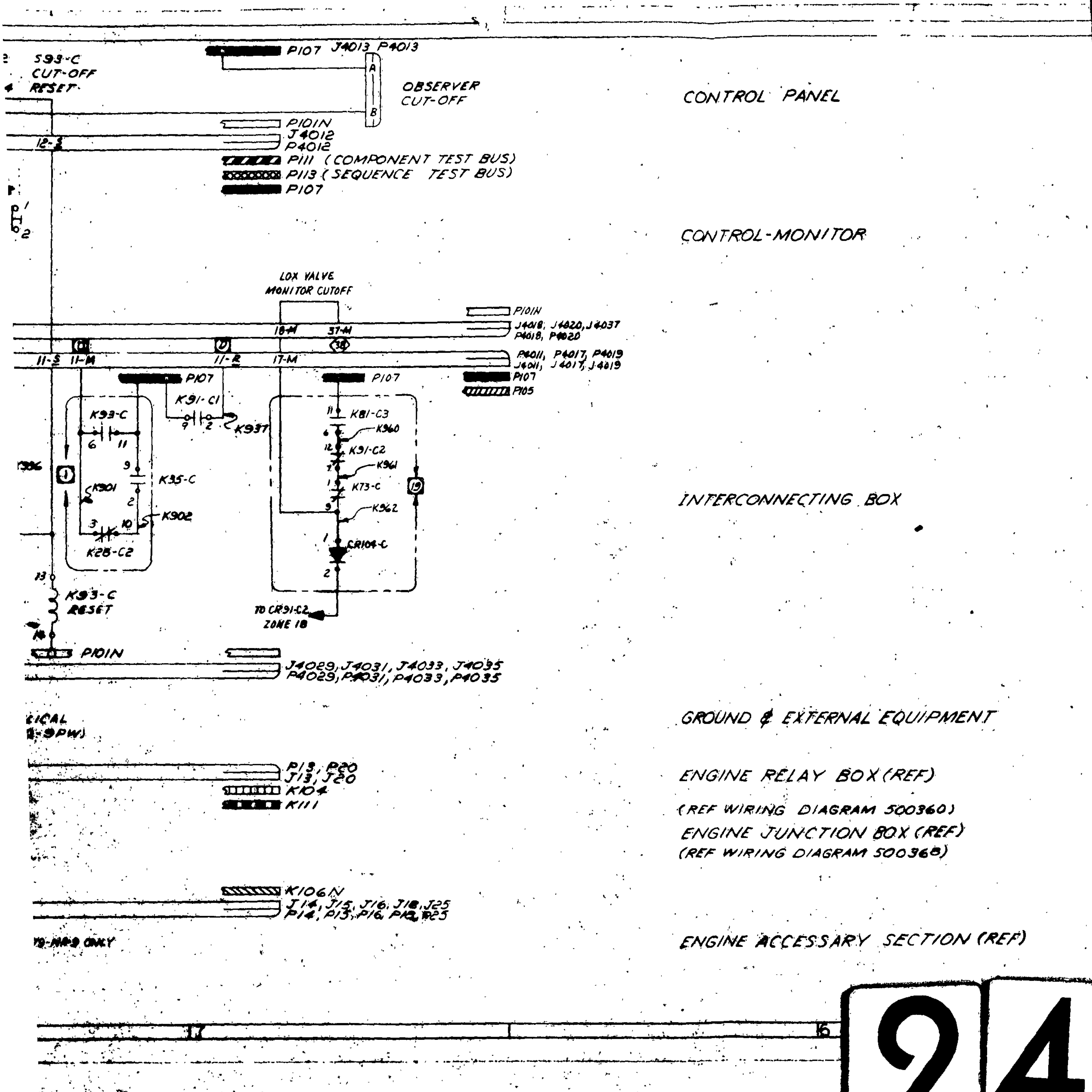
21


P107
P10N
P111
P113
P105
DS92-C1 MAIN ENGINE CUT-OFF
S92-C MAIN ENGINE CUT-OFF
DS91-C1 V. E. CUT-OFF
S1185-C CUT-OFF CIRCUIT LOCK-OUT
STATIC FIRE
DS92-C2 MAIN ENGINE CUT-OFF
DS91-C2 V. E. CUT-OFF
MAIN ENG. CUT-OFF
PROP. DEPLETION CUT-OFF
SLOW BUILD-UP CUT-OFF
HIGH TEMPERATURE CUT-OFF
GROUND POWER FAILURE CUT-OFF
IGNITION STAGE TIMER CUT-OFF
12-T
12-S
12-R
20-M
20-L
19-M
19-L
11-T
11-S
17-P
17-N
17-O
19-K
11-R
TO K132-T4-10 ZONE 19
P4092 J4092
J4092 P4092
K85-C STATIC FIRE
K86-C CUT-OFF LOCK-OUT
K91-C2 CUT-OFF
CR92-C
CR94-C
CR101-C
CR102-C
CR97-C
CR96-C
TO P4092-E ZONE 20
K132-T4
K13-C1-1 ZONE 43
K96-C FUEL MANIFOLD PRESS SW PICK-UP
K62-I
29-Y
35-C
35-B
35-A
33-A
P186 J186
S84-C FUEL MANIFOLD PRESSURE SWITCH
HIGH TEMPERATURE CUT-OFF
2-V
13-B
K104
K99-C1
K99-C2 MAIN ENGINE CUT-OFF
K106N
K715
K716
K704
K72-C4
K72-C1
K717
K722
K724
K725
18-E
18-D
18-C
18-F
18-J
18-V
18-T
18-P
MAIN ENGINE CUT-OFF SIGNAL TO MISSILE
MAIN LIFT-OFF SWITCH
MAIN ENGINE COMMAND CUT-OFF
DSV-2C ARMING CONTACTS
19

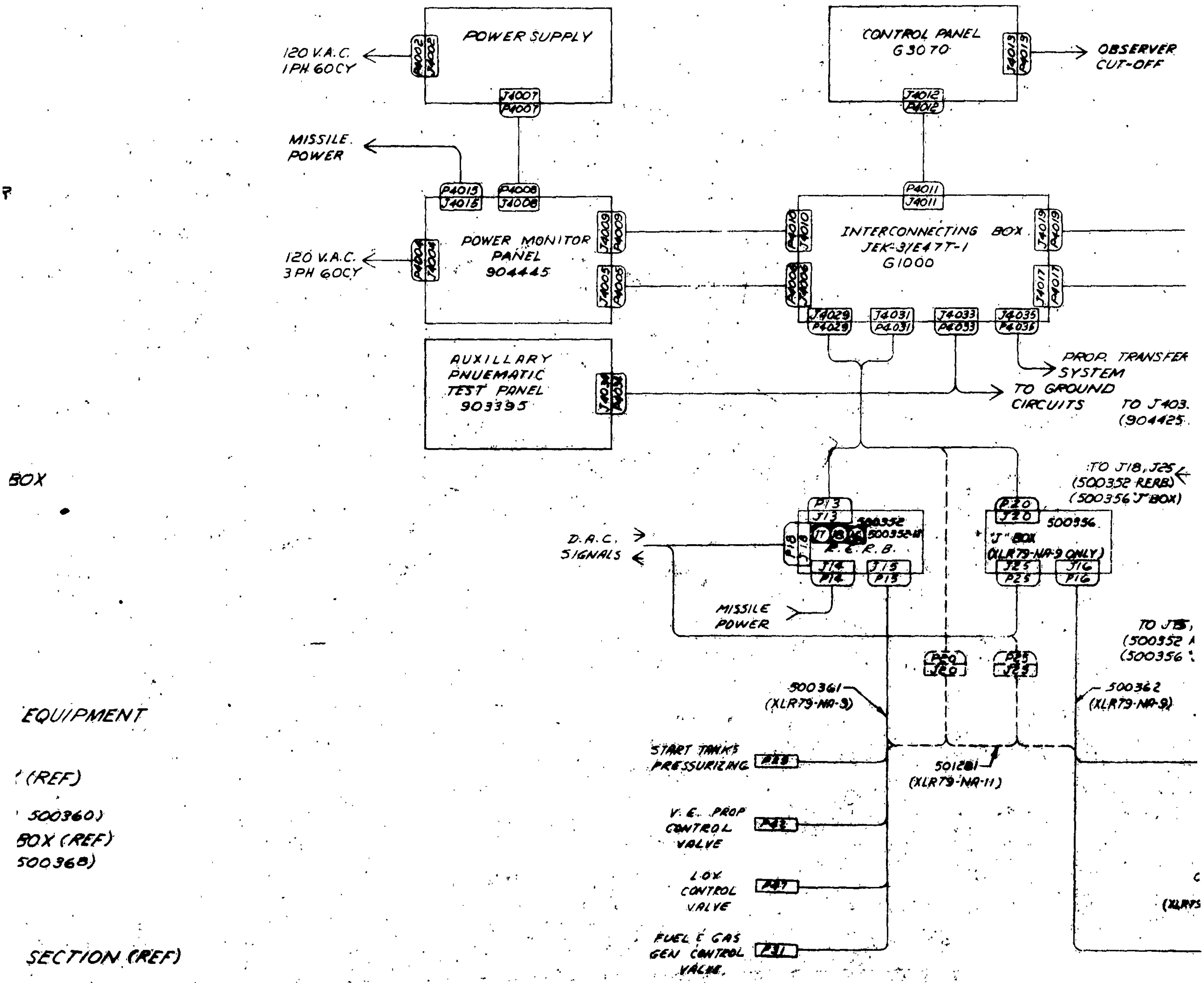


P107
S91-C1
V.E.
CUT-OFF
K930
K931
S93-C
CUT-OFF
RESET
12-P
12-S
P113
S91-C2
V.E.
CUT-OFF
P107
S1193-C
CUT-OFF
RESET
HIGH
TEMPERATURE
CUT-OFF
GROUND
POWER
FAILURE
CUT-OFF
IGNITION
STAGE
TIMER
CUT-OFF
START
TANKS
MONITOR
CUT-OFF
V.E.
CUT-OFF
COMBUSTION
STABILITY
MONITOR
CUT-OFF
K627
PROP
TRANSFER
HOLD
CUT-OFF
K923
TURBINE
OVERSPEED TRIP
CUT-OFF
K914
K13-C1-1
ZONE
43
CR96-C
K922
P107
K31-F
K31-S
K919
K921
K71-F
K71-S
CR102-C
CR97-C
K62-I
P4091
J4091
K924
K918
K917
P107
K61-C2
K938
K132-T4
K933
K17-C2
K935
K50-C
CR95-C
K929
CR93-C
CR91-C
K86-C
K932
K920
CR98-C
P107
K51-C2
K904
K71-S
K94-C
K31-S
K925
K903
CR99-C
K934
TO CR104-C2
ZONE 17
K936
K93-C
K35-C
K901
K902
K28-C2
K93-C
RESET
P101N
33-A
31-Z
29-d
HIGH
TEMPERATURE
CUT-OFF
NO. 2 UMBILICAL
(6B-107640-9PW)
(TYP)(REF)
2-I
2-K
13-A
20-D
K711
K98-C1
K98-C2
V.E.
CUT-OFF
K106N
K111
K721
K72-C1
K724
K725
18-T
18-P
18-R
16-S
16-R
P50
J50
XLR79-NA-9 ONLY
S91-C
TURBINE OVERSPEED TRIP
ARC ARMING
CONTACTS
V.E.
COMMAND
CUT-OFF
18
17

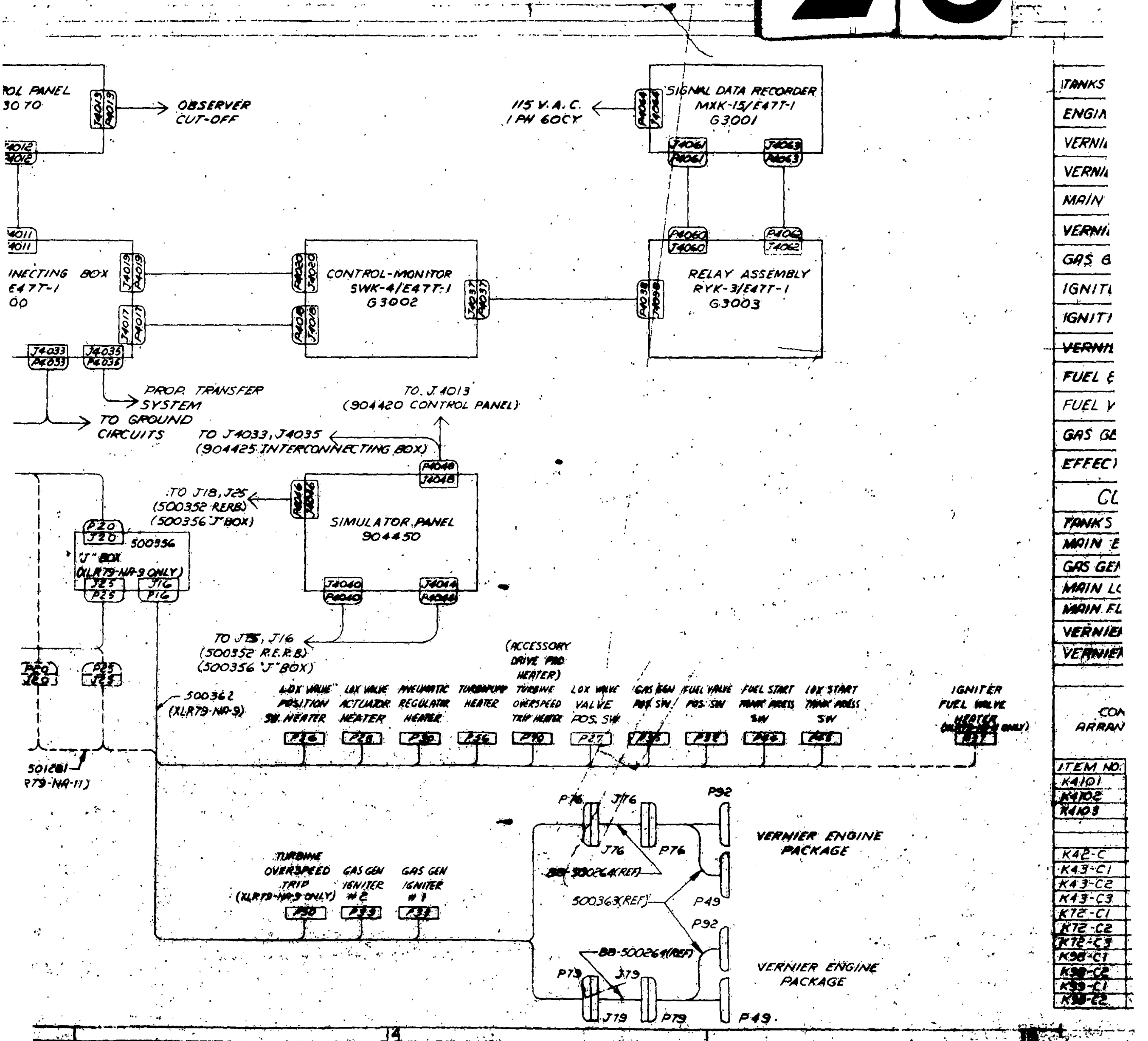
23



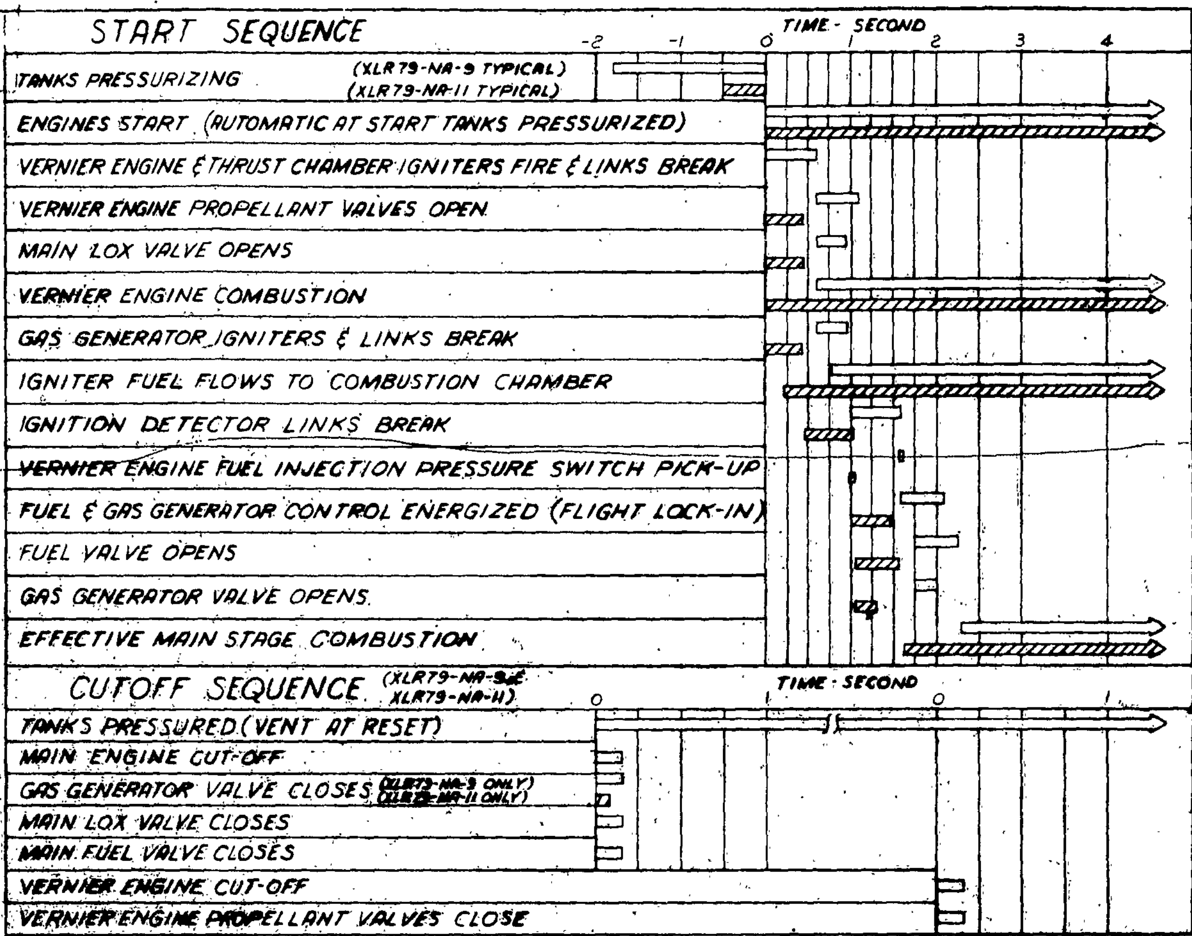
S93-C
CUT-OFF
RESET
P107
J4013 P4013
OBSERVER
CUT-OFF
CONTROL PANEL
P101N
J4012
P4012
12-S
P111 (COMPONENT TEST BUS)
P113 (SEQUENCE TEST BUS)
P107
CONTROL-MONITOR
LOX VALVE
MONITOR CUTOFF
P101N
J4018, J4020, J4037
P4018, P4020
18-M
37-M
11-S
11-M
11-R
17-M
P4011, P4017, P4019
J4011, J4017, J4019
P107
P105
K93-C
K91-C1
K937
K81-C3
K960
K91-C2
K961
K35-C
K73-C
K901
K902
K962
K28-C2
CR104-C
INTERCONNECTING BOX
K93-C
RESET
TO CR91-C2
ZONE 18
P101N
J4029, J4031, J4033, J4035
P4029, P4031, P4033, P4035
GROUND & EXTERNAL EQUIPMENT
P13, P20
J13, J20
K104
K111
ENGINE RELAY BOX (REF)
(REF WIRING DIAGRAM 500360)
ENGINE JUNCTION BOX (REF)
(REF WIRING DIAGRAM 500368)
K106N
J14, J15, J16, J18, J25
P14, P15, P16, P18, P25
ENGINE ACCESSARY SECTION (REF)
17
16



POWER SUPPLY
120 V.A.C. 1 PH 60CY
P4002 J4002
J4007 P4007
CONTROL PANEL G3070
J4019 P4019
OBSERVER CUT-OFF
J4012 P4012
MISSILE POWER
P4015 J4015
P4008 J4008
POWER MONITOR PANEL 904445
120 V.A.C. 3 PH 60CY
P4004 J4004
J4009 P4009
J4005 P4005
P4011 J4011
INTERCONNECTING BOX JEK-3/E47T-1 G1000
P4010 J4010
P4006 J4006
J4019 P4019
J4017 P4017
J4029 P4029
J4031 P4031
J4033 P4033
J4035 P4035
PROP. TRANSFER SYSTEM
AUXILLARY PNUEMATIC TEST PANEL 903395
TO GROUND CIRCUITS
TO J403. (904425
BOX
TO J18, J25 (500352 RERB) (500356 "J" BOX)
P13 J13
500352 500352-B
R.E.R.B.
D.A.C. SIGNALS
J14 P14
J15 P15
P20 J20
500356
"J" BOX (XLR79-NA-9 ONLY)
J25 P25
J16 P16
MISSILE POWER
TO J15, (500352 (500356
EQUIPMENT
500361 (XLR79-NA-3)
500362 (XLR79-NA-9)
501281 (XLR79-NA-11)
START TANKS PRESSURIZING
V.E. PROP CONTROL VALVE
LOX CONTROL VALVE
FUEL & GAS GEN CONTROL VALVE
P31
(REF)
500360)
BOX (REF)
500368)
SECTION (REF)



ROL PANEL
3070
OBSERVER CUT-OFF
SIGNAL DATA RECORDER MXK-15/E47T-1 G3001
115 V.A.C. 1 PH 60CY
INECTING BOX
E47T-1
00
CONTROL-MONITOR SWK-4/E47T-1 G3002
RELAY ASSEMBLY RYK-3/E47T-1 G3003
PROP. TRANSFER SYSTEM
TO GROUND CIRCUITS
TO J4013 (904420 CONTROL PANEL)
TO J4033, J4035 (904425 INTERCONNECTING BOX)
TO J18, J25 (500352 RERB) (500356 "J" BOX)
SIMULATOR PANEL 904450
500356 "J" BOX (XLR79-NA-9 ONLY)
TO J15, J16 (500352 R.E.R.B.) (500356 "J" BOX)
500362 (XLR79-NA-9)
501281
R79-NA-11)
LOX VALVE POSITION SW. HEATER
LOX VALVE ACTUATOR HEATER
PNEUMATIC REGULATOR HEATER
TURBOPUMP HEATER
(ACCESSORY DRIVE PAD HEATER) TURBINE OVERSPEED TRIP HEATER
LOX VALVE VALVE POS. SW
GAS GEN POS SW.
FUEL VALVE POS. SW
FUEL START TANK PRESS SW
LOX START TANK PRESS SW
IGNITER FUEL VALVE HEATER
TURBINE OVERSPEED TRIP (XLR79-NA-9 ONLY)
GAS GEN IGNITER #2
GAS GEN IGNITER #1
VERNIER ENGINE PACKAGE
BB-500264(REF)
500363(REF)
P76 J76 P92 P49 P79 J79
TANKS
ENGIN
VERNI
VERNI
MAIN
VERNI
GAS G
IGNIT
IGNIT
VERNI
FUEL
FUEL V
GAS GE
EFFEC
CL
TANKS
MAIN E
GAS GEN
MAIN L
MAIN FL
VERNIER
VERNIER
CON ARRAN
ITEM NO.
K4101
K4102
K4103
K42-C
K43-C1
K43-C2
K43-C3
K72-C1
K72-C2
K72-C3
K98-C1
K98-C2
K99-C1
K99-C2



IGNITER FUEL VALVE HEATER (XLR79-NA-11 ONLY) K41

RELAY						COIL	CONTACTS									
CONTACT ARRANGEMENT			19-903883			1/8	3/4	3/2	6/5	6/7						
			RD455-1001-0001			X1/X2	A1/A2									
			NA5-27103 T1 (MV 7002 ELGIN (18))			4/8	3/6	3/5	7/2	7/1						
			MHYX-4003			13/14	9/2	9/1	10/4	10/3	11/6	11/5	12/8	12/7		
ITEM NO.	COIL LOC	DESC	PART NO	MFGR	SPECIFICATION	NO	NC	NO	NC	NO	NC	NO	NC	NO	NC	NO
K4101	49	1P 1T	RD455-1001-0001			48										
K4102	49	4P 2T	MHYX-4009	ALLIED		48										
K4103	48	2P 2T	19-903380			48	48	48								
K42-C	35	2P 2T	NA5-27103T1			35		35								
K43-C1	31					31		29								
K43-C2	31					31		36								
K43-C3	31							35								
K72-C1	23					23		22								
K72-C2	23					23		22								
K72-C3	23					38		27								
K98-C1	18						31	18								
K98-C2	18						31									
K99-C1	20					20			23							
K99-C2	20	2P 2T	NA5-27103T1			20		35	23							

CONT ARRAN

ITEM NO.	CO
K11-C	4
K13-C1	4
K13-C2	4
K14-C	4
K15-C	4
K16-C	4
K17-C1	4
K17-C2	4
K21-C	4
K22-F	3
K23-C	3
K24-C	3
K25-C	4
K26-C	3
K28-C1	3
K28-C2	3
K31-C1	4
K31-C2	4
K31-F	2
K31-S	2
K31-V	2
K37-C	3
K32-O	3
K33-C1	4
K33-C2	4
K33-V	2
K39-C1	3
K39-C2	3
K35-C	3
K36-C1	3
K36-C2	3
K41-C	3
K44-C	3
K50-C	35
K51-C1	34
K51-C2	34
K53-I	33
K55-I	32
K58-T	33
K59-V	23
K61-C1	27
K61-C2	27

28

4

RELAYS

CONTACT ARRANGEMENT

PART NO	MFGR / SPEC	COIL		CONTACTS							
MS24143-1	MIL-R-6106	X1/X2	A1/A2	B1/B2	C1/C2						
MS24140-1	MIL-R-6106	X1/X2	A1/A2								
MHYX-4003											
MHYX-4020	ALLIED	13/14	9/2	9/1	10/4	10/3	11/6	11/5	12/8	12/7	
2112-D-H3	AGASTAT	A/H	B/D	B/C	B/E	F/G					
HF-01 (N.C.)	G-V CONTROLS	2/3		5/7							
HF-01 (N.O.)	G-V CONTROLS	2/3	5/7								

ITEM NO.	COIL LOC	DESC	PART NO	MFGR	SPECIFICATION	NO	NC	NO	NC	NO	NC	NO	NC	NO	NC	NO	NC
K11-C	45	1P 1T	MS24140-1		MIL-R-6106	45											
K13-C1	44	4P 2T	MHYX-4003	ALLIED													
K13-C2	44	1P 1T	MS24140-1				43	19									
K14-C	44	3P 2T	MS24143-1		MIL-R-6106	44											
K15-C	43	3P 2T	MS24143-1			45		45		45							
K16-C	43	1P 1T	MS24140-1					45		45							
K17-C1	43	4P 2T	MHYX-4003	ALLIED	MIL-R-6106	44											
K17-C2	43					38	38	39	39	38	38	39	39				
K21-C	41						19		35	18							
K22-F	38					35		41		39							
K23-C	34					37											
K24-C	37						34	34									
K25-C	40					37											
K26-C	39						40										
							40										
K28-C1	34																
K28-C2	34						36	34		41	40	34					
						34			17								
K31-C1	41																
K31-C2	41					33		32		31		24					
K31-F	21					25											
K31-S	22						20	18									
K31-V	29					17			20	18							
K37-C	36								23								
K32-O	39					26		25									
K33-C1	40					39	39										
K33-C2	40						41	36		31		33					
K33-V	28					32		25				34					
K39-C1	38								23								
K39-C2	38					36	36		33		32		31				
K35-C	37	4P 2T	MHYX-4003	ALLIED		41											
K36-C1	36	1P 1T	MS24140-1			17		36		36		34					
K36-C2	36	1P 1T	MS24140-1		MIL-R-6106	33											
K41-C	36	4P 2T	MHYX-4003	ALLIED	MIL-R-6106	26											
K44-C	35	2P 2T	2112-D-H3	AGASTAT		36		35			39						
						36											
K50-C	35	4P 2T	MHYX-4003	ALLIED													
K51-C1	34		MHYX-4003				18										
K51-C2	34		MHYX-4003			34		31		33		32					
						30		33		23		17					
K53-I	33		MHYX-4020														
						33		33		41			30				
K55-I	32		MHYX-4020														
						32		32		41			30				
K58-T	33		MHYX-4003														
K59-V	23						33		32		31						
						23		23			39						
K61-C1	27																
K61-C2	27	4P 2T	MHYX-4003	ALLIED		26		25		20		27					
							33	18		43							

CONTACT ARRANGEMENT

ITEM NO	COIL LOC	DESC
K62-I	34	2P 2T
K64-I	31	4P 2T
K66-I	24	
K71-F	21	
K71-O	26	
K71-S	21	
K73-C	28	
K75-I	25	
K78-T	25	
K81-C1	22	
K81-C2	22	4P 2T
K81-C3	22	4P 2T
K82-C	20	2P 2T
K85-C	20	4P 2T
K86-C	20	
K91-C1	19	
K91-C2	19	
K93-C	17	
K94-C	35	
K95-C	36	4P 2T
K96-C	19	4P 2T
K111-T	43	1P 1T
K112-T	43	4P 2T
K113-T	41	4P 2T
K131-T	42	1P 1T
K132-T1	42	4P 2T
K132-T2	42	
K132-T3	42	
K132-T4	42	
K133-T	41	
K141-T1	42	
K141-T2	42	4P 2T
K1352-V	29	1P 1T
K1354-V	28	1P 1T
K1361-L	26	1P 1T

RELAYS		COIL	CONTACTS											
CONTACT ARRANGEMENT	MS24140-1 MIL-R-6106	X1/X2	A1/A2											
	MHYX-4003 MHYX-4020 ALLIED	13/14	9/2	9/1	10/4	10/3	11/6	11/5	12/8	12/7				
	2112-D-H3 AGASTAT	A/H	B/D	B/C	G/E	F/B								
	HF-01 (N.C.) G-V CONTROLS	2/3		5/7										
	HF-01 (N.O.) G-V CONTROLS	2/3	5/7											

ITEM NO	COIL LOC	DESC	PART NO	MFGR	SPECIFICATION	NO	NC	NO	NC	NO	NC	NO	NC	NO	NC	NO	NC
K62-I	34	2P 2T	2112-D-H3	AGASTAT		18		33									
K64-I	31	4P 2T	MHYX-4020	ALLIED		41		31			30	31					
K66-I	24		MHYX-4003			41			23	24		24					
K71-F	21						18					21					
K71-O	26					23		26			25						
K71-S	21		MHYX-4003				17		18			21					
K73-C	28		MHYX-4003				17					21					
K75-I	25		MHYX-4020			25		25	20	41		23	23				
K78-T	25		MHYX-4003				25										
K81-C1	22						44		36		23		38				
K81-C2	22	4P 2T	MHYX-4003	ALLIED			27		44		34	22					
K81-C3	22	4P 2T	MHYX-4003	ALLIED		17	30		43								
K82-C	20	2P 2T	2112-D-H3	AGASTAT			36		20								
K85-C	20	4P 2T	MHYX-4003	ALLIED			20										
K86-C	20						20		18								
K91-C1	19					17	44		36		41	19	34				
K91-C2	19						42	23	17		35						
K93-C	17						20		22	17	19	19					
K94-C	35					17			36		36						
K95-C	36	4P 2T	MHYX-4003	ALLIED		36		36			36						
K96-C	19	4P 2T	MHYX-4003	ALLIED		19	19	19		19							
K111-T	43	1P 1T	MS24140-1		MIL-R-6106	42											
K112-T	43	4P 2T	MHYX-4003	ALLIED			27										
K113-T	41	4P 2T	MHYX-4003	ALLIED		29		27		22							
K131-T	42	1P 1T	MS24140-1		MIL-R-6106	42											
K132-T1	42	4P 2T	MHYX-4003	ALLIED		44	44		35	33	33		32				
K132-T2	42					23			31	24	24	34					
K132-T3	42					26	26		25	43		44					
K132-T4	42					35			19				18				
K133-T	41					29		28		26		41					
K141-T1	42										40		36				
K141-T2	42	4P 2T	MHYX-4003	ALLIED			39		41								
K1352-V	29	1P 1T	HF-01	G-V CONTROLS		23											
K1354-V	28	1P 1T	HF-01			23											
K1361-L	26	1P 1T	HF-01	G-V CONTROLS			24										

(RERB)			RESERVED W	
X4	P101	K201	K301	K401
X6	P102	K202	K302	K402
X7	P103	K203	K303	K403
X11	P104	K204	K304	K404
X12	P105	K205	K305	K405
X2N	P106	K206	K306	K406
K104	P107	K207	K307	K407
K106N	P108	K208	K308	K408
K108N	P109		K309	K409
K111	K110	K210	K310	K410
K188	P111	K211	K311	K411
K218	P112	K212	K312	K412
K219	P113	K213	K313	K413
K301	P114		K314	K414
K306	P115		K315	K415
K307	K116		K316	K416
K317			K317	K417
K318			K318	K418
K328		K219	K319	K419
V305		K220	K320	K420
K340		K221	K321	K421
K349		K222	K322	K422
K356		K223	K323	K423
K358		K224	K324	K424
K360		K225	K325	K425
K391		K226	K326	K426
K400		K227	K327	K427
K404		K228	K328	
K414		K229	K329	
K424			K330	K430
K429		K231	K331	
K433			K332	
K434			K333	
K507			K334	
K511			K335	
K514				
K516				
K524				
K531				
K532				
K533				
K535				
K556				
K558				
K601				
K603				
K704				
K711				
K715				
K716				
K721				

	RELAYS		COIL		CONTACTS								
	MS24140-1	MIL-R-6106	X1/X2	A1/A2									
ACT MENT	MHYX-4003 MHYX-4020	ALLIED	13/14	9/2	9/1	10/4	10/3	11/6	11/5	12/8	12/7		
	2112-D-H3	AGASTAT	A/H	B/D	B/C	G/E	F/6						
	HF-01 (N.C.)	G-V CONTROLS	2/3		5/7								
	HF-01(N.O.)	G-V CONTROLS	2/3	3/4									

LOC	DESC	PART NO	MFGR	SPECIFICATION	NO	NC	NO	NC	NO	NC	NO	NC	NO	NC	NO	NC
4	2P 2T	2112-D-H3	AGASTAT		18		33									
1	4P 2T	MHYX-4020	ALLIED		41		31			30	31					
4		MHYX-4003			41			23	24		24					
1						18					21					
6					23		26			25						
1		MHYX-4003				17		18			21					
8		MHYX-4003				17					21					
5		MHYX-4020			25		25	20	41		23	23				
5		MHYX-4003				25										
2						44		36		23		38				
2	4P 2T	MHYX-4003	ALLIED			27		44		34	22					
2	4P 2T	MHYX-4003	ALLIED		17	30		43								
0	2P 2T	2112-D-H3	AGASTAT			36		20								
0	4P 2T	MHYX-4003	ALLIED			20										
0						20		18								
9					17	44		36		41	19	34				
9						42	23	17		35						
7						20		22	17	19	19					
5					17			36		36						
6	4P 2T	MHYX-4003	ALLIED		36		36			36						
0	4P 2T	MHYX-4003	ALLIED		19	19	19		19							
	1P 1T	MS24140-1		MIL-R-6106	42											
	4P 2T	MHYX-4003	ALLIED			27										
	4P 2T	MHYX-4003	ALLIED		29		27		22							
	1P 1T	MS24140-1		MIL-R-6106	42											
	4P 2T	MHYX-4003	ALLIED		44	44		35	33	33		32				
					23			31	24	24	34					
					26	26		25	43		44					
					35			19				18				
					29		28		26		41					
										40		36				
	4P 2T	MHYX-4003	ALLIED			39		41								
	1P 1T	HF-01	G-V CONTROLS		23											
	1P 1T	HF-01			23											
	1P 1T	HF-01	G-V CONTROLS			24										

(RERB)			RESERVED WIRE NUMBERS			
X4	P101	K201	K301	K401	K501	K601
X6	P102	K202	K302	K402	K502	K602
X7	P103	K203	K309	K403	K503	K603
X11	P104	K204	K304	K404	K504	K604
X12	P105	K205	K305	K405	K505	
X2N	P106	K206	K306	K406	K506	K606
K104	P107	K207	K307	K407	K507	K607
K106N	P108	K208	K308	K408	K508	K608
K108N	P109		K309	K409	K509	K609
K111	K110	K210	K310	K410	K510	
K188	P111	K211	K311	K411	K511	K611
K218	P112	K212	K312	K412	K512	K612
K219	P113	K213	K313	K413	K513	K613
K301	P114		K314	K414	K514	K614
K306	P115		K315	K415	K515	K615
K307	K116		K316	K416	K516	K616
K317			K317	K417	K517	K617
K318			K318	K418	K518	K618
K328		K219	K319	K419	K519	K619
V305		K220	K320	K420	K520	K620
K340		K221	K321	K421	K521	K621
K343		K222	K322	K422	K522	K622
K356		K223	K323	K423	K523	
K358		K224	K324	K424	K524	K624
K360		K225	K325	K425	K525	K625
K391		K226	K326	K426	K526	K626
K400		K227	K327	K427	K527	K627
K404		K228	K328		K528	
K414		K229	K329		K529	
K424			K330	K430	K530	
K429		K231	K331		K531	
K433			K332		K532	
K434			K333		K533	
K507			K334		K534	
K511			K335		K535	
K514					K536	
K516					K537	
K524					K538	
K531					K539	
K532					K540	
K533					K541	
K535					K542	
K556					K543	
K558					K544	
K601						
K603						
K704					K547	
K711					K548	
K715					K549	
K716						
K721						
					K552	

RESERVED WIRE NUMBERS

K301	K401	K501	K601	K701	K101N	K901	X1A
K302	K402	K502	K602	K702	P101N	K902	X1B
K303	K403	K503	K603	K703		K903	X1C
K304	K404	K504	K604	K704		K904	X1N
K305	K405	K505		K705		K905	X2A
K306	K406	K506	K606	K706		K906	X2B
K307	K407	K507	K607	K707		K907	X2C
K308	K408	K508	K608			K908	X3A
K309	K409	K509	K609	K709		K909	X3B
K310	K410	K510		K710		K910	X3C
K311	K411	K511	K611	K711		K911	X4A
K312	K412	K512	K612	K712		K912	X4B
K313	K413	K513	K613			K913	X4C
K314	K414	K514	K614	K714		K914	X5A
K315	K415	K515	K615	K715		K915	
K316	K416	K516	K616	K716		K916	X5C
K317	K417	K517	K617	K717		K917	X6A
K318	K418	K518	K618	K718		K918	X6B
K319	K419	K519	K619	K719		K919	
K320	K420	K520	K620	K720		K920	
K321	K421	K521	K621	K721		K921	
K322	K422	K522	K622	K722		K922	P10
K323	K423	K523		K723		K923	P11N
K324	K424	K524	K624	K724		K924	X12
K325	K425	K525	K625	K725		K925	X13N
K326	K426	K526	K626			K926	X14N
K327	K427	K527	K627	K727		K927	P15
K328		K528				K928	X16
K329		K529				K929	X17N
K330	K430	K530				K930	K18
K331		K531				K931	K19
K332		K532		K732		K932	K20
K333		K533				K933	K21
K334		K534		K734		K934	X22N
K335		K535				K935	X23N
		K536		K736		K936	P24
		K537		K737		K937	
		K538		K738		K938	
		K539		K739		K939	
		K540		K740			
		K541		K741		K941	
		K542				K942	
		K543					
		K544					
				K745			
				K746			
		K547		K747			
		K548		K748		K954	
		K549		K749			
				K750			
		K552					
						K960	
						K961	
						K962	
						K963	
						K964	
						K965	

SWITCHES

ITEM NO.	LOC.	DESC		PART NO.	MFGR.	SPEC
S11-C	46	1P	2T	AN3021-3		MIL-S-6745
S13-C	44			AN3021-3		
S20-C	42			AN3021-3		
S21-C	41	1P	2T	AN3021-3		
S39-C	38	1P	2T	AN3022-3		MIL-S-6745
S91-C1	18	2 CIRCUIT		W103L5-ALR	HETHERINGTON	
S91-C2	18	1 CIRCUIT		MS25089-3FB		MIL-S-6743
S92-C	19	2 CIRCUIT		MS25089-3FR		MIL-S-6743
S93-C	17	1 CIRCUIT		MS25089-3FB		MIL-S-6743
S111-T	43	1P	2T	AN3021-3		MIL-S-6745
S131-C	44			AN3021-3		
S131-T	42			AN3021-3		
S1121-F	38			AN3021-3		
S1122-C	37			AN3021-3		
S1123-F	38			AN3021-3		
S1124-C	37			AN3021-3		
S1125-F1	40			AN3021-3		
S1125-F2	40			AN3021-3		
S1126-01	39			AN3021-3		
S1126-02	39			AN3021-3		
S1128-C	34			AN3021-3		
S1132-O	39	1P	2T	AN3021-3		
S1135-C	37	1P	1T	AN3021-11		
S1141-O	30	2P	2T	AN3027-3		
S1151-V	30					
S1171-O	27					
S1172-F	27	2P	2T	AN3027-3		
S1185-C	20	1P	2T	AN3021-3		MIL-S-6745
S1193-C	17	1 CIRCUIT		MS25089-3FB		MIL-S-6743
S4101	49	1P	2T	MS25038-23		MIL-S-6745

ITEM N
DS12-
DS13-
DS14-C
DS15-C
DS20-
DS21-
DS21-
DS22-
DS22-
DS24-C
DS25-C
DS26-C
DS28-C
DS31-
DS31-C
DS31-S
DS31-V
DS32-O
DS33-C
DS33-V
DS34-C
DS42-F
DS51-V
DS52-V
DS53-I
DS54-V
DS55-I
DS59-V
DS64-I
DS66-I
DS71-C
DS71-F
DS71-O
DS72-C
DS72-F
DS72-O
DS75-S
DS91-C1
DS91-C2
DS92-C1
DS92-C2
DS111-T
DS131-T
DS4101
DS4102
DS4103

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R.	SPEC
	MIL-S-6745
	MIL-S-6745
IGTON	
	MIL-S-6743
	MIL-S-6743
	MIL-S-6743
	MIL-S-6745
	MIL-S-6745
	MIL-S-6743
	MIL-S-6745

INDICATING LIGHTS

ITEM NO.	LOC.	DESC.	PART NO.	MFGR	SPEC
DS12-C	45	WHITE	19-902426	KORRY	
DS13-C	44		19-902401		
DS14-C	45		19-902402		
DS15-C	43	WHITE	19-902403		
DS20-C	42	GREEN	19-902404		
DS21-C	41		19-902405		
DS21-F	38		19-902406		
DS22-C	38		19-902408		
DS22-0	37		19-902407		
DS24-C	37		19-902409		
DS25-C	40		19-902410		
DS26-C	40		19-902411		
DS28-C	34		19-902416		
DS31-F	21		19-902463		
DS31-O	26		19-902464		
DS31-S	22		19-902465		
DS31-V	29		19-902466		
DS32-O	39		19-902412		
DS33-C	40		19-902413		
DS33-V	28		19-902414		
DS34-C	34		19-902415		
DS42-F	35		19-902435		
DS51-V	29		19-902418		
DS52-V	29		19-902419		
DS53-I	33		19-902420		
DS54-V	28		19-902421		
DS55-I	32		19-902422		
DS59-V	23		19-902423		
DS64-I	31		19-902443		
DS66-I	24		19-902425		
DS71-C	21		19-902444		
DS71-F	20		19-902427		
DS71-O	28		19-902428		
DS72-C	25		19-902429		
DS72-F	22		19-902430		
DS72-O	26		19-902431		
DS75-S	21	GREEN	19-902432		
DS91-C1	19	RED	19-902434		
DS91-C2	19	RED	19-902434		
DS92-C1	19	RED	19-902436		
DS92-C2	19	RED	19-902445		
DS111-T	43	GREEN	19-902437		
DS131-T	42	GREEN	19-902438	KORRY	
DS4101	49	WHITE	RD332-0001-0027		
DS4102	48	GREEN	RD332-[illegible]		
[illegible]	48	RED	[illegible]		

MISCELLANEOUS

ITEM NO	LOC	DESC	PART NO.	MFGR	SPEC
CB11-C1	46	IP IT	D7271-1-5	SPENCER-THERMOSTAT	
CB11-C2	46		D7271-1-20		
CB13-C1	46		D7271-1-25		
CB-13-C2	46		D7271-1-25		
CB-13-C3	46	IP IT	D7271-1-25	SPENCER-THERMOSTAT	
CR50-C	35	RECTIFIER	3DT1	INTERNATIONAL	
CR70-C	23				
CR81-C	22				
CR82-C	22				
CR91-C	18				
CR92-C	19				
CR93-C	18				
CR94-C	19				
CR95-C	18				
CR96-C	20				
CR97-C	18				
CR98-C	17				
CR99-C	18				
CR100-C	43				
CR101-C	19				
CR102-C	19	RECTIFIER	3DT1	INTERNATIONAL	
CR103-C		RECTIFIER	3HT1	INTERNATIONAL	
CR104-C		RECTIFIER	3HT1	INTERNATIONAL	
M11-C1	46	0-50 VOLTS	[illegible]		MIL-M-10[illegible]
M11-C2	46	0-20 AMPS	[illegible]		
M12-C1	46	0-30 AMPS	[illegible]		
M12-C2	46	0-30 AMPS	[illegible]		
M12-C3	46	0-30 AMPS	[illegible]		MIL-M-[illegible]

'ELLANEOUS		
PART NO.	MFGR.	SPEC
D7271-1-5	SPENCER-THERMOSTAT	
D7271-1-20		
D7271-1-25		
D7271-1-25		
D7271-1-25	SPENCER-THERMOSTAT	
3DT1	INTERNATIONAL	
3DT1	INTERNATIONAL	
3HT1	INTERNATIONAL	
3HT1	INTERNATIONAL	
[illegible]		MIL-M-10304
[illegible]		
[illegible]		
[illegible]		
[illegible]		MIL-M-10304

RESISTORS					
ITEM NO	LOC.	DESC.	PART NO	MFGR	SPEC
R11-C1	46		M.S.A 200		MIL-S-61
R11-C2	46		M.S A 200		MIL-S-61
R12-C	44	1300 Ω 25W	RH-25 1300 Ω ±5%	DALE PRODUCT	MIL-R-18546
R14-C	45	1300 Ω 25W	RH-25 1300 Ω ±5%		
R51-I	33	3 Ω 100W	RH-100 3 Ω ±5%		
R52-I1	33	50 Ω 50W	RH-50 50 Ω ±5%		
R52-I3	33	30 Ω 50W	RH-50 30 Ω ±5%		
R52-I4	33	20 Ω 50W	RH-50 20 Ω ±5%		
R53-I	32	3 Ω 100W	RH-100 3 Ω ±5%		
R54-I1	32	50 Ω 50W	RH-50 50 Ω ±5%		
R54-I3	32	30 Ω 50W	RH-50 30 Ω ±5%		
R54-I4	32	20 Ω 50W	RH-50 20 Ω ±5%		
R61-I	31	3 Ω 100W	RH-100 3 Ω ±5%		
R62-I1	31	50 Ω 50W	RH-50 50 Ω ±5%		
R62-I3	31	30 Ω 50W	RH-50 30 Ω ±5%		
R62-I4	31	20 Ω 50W	RH-50 20 Ω ±5%		
R66-I	24	25 Ω 50W	RH-50 25 Ω ±5%		
R71-I1	26	3 Ω 100W	RH-100 3 Ω ±5%		
R71-I2	25	3 Ω 100W	RH-100 3 Ω ±5%		
R75-I1	25	50 Ω 50W	RH-50 50 Ω ±5%		
R75-I3	25	30 Ω 50W	RH-50 30 Ω ±5%		
R75-I4	25	20 Ω 50W	RH-50 20 Ω ±5%		MIL-R-18546
R4101	49	2.5K 10W	RH-10-[illegible]-3		
R4102	49	2.5K 10W	RH-10-[illegible]-3	DALE PRODUCT	

CONNECTORS			
ITEM NO	LOC	DESC	PART NO
J4002	15	4 CONTACTS	MS3102E20-4P
P4002	15	4	MS3106E20-4S
J37	15	4	
P37	15	4	MS3108E14S-2S(LI
J4004	15	7	MS3102E24-10
P4004	15	7	MS3106E24-10
J4005	15	7	MS3102E24-10
P4005	15	7	MS3106E24-10
J4006	15	7	MS3102E24-10
P4006	15	7	MS3106E24-10
J4007	15	6	MS3102E20-22
P4007	15	6	MS3106E20-22
J4008	15	6	MS3102E20-22
P4008	15	6	MS3106E20-22
J4009	15	6	MS3102E20-22
P4009	15	6	MS3106E20-22
J4010	15	6	GP3102E20-22
P4010	15	6	MS3106E20-22
J4011	15	37	GP3102E28-21S
P4011	15	37	MS3106E28-21
J4012	15	37	MS3102E28-21
P4012	15	37	MS3106E28-21
J4013	14	3	MS3102E14S-7
P4013	14	3	MS3106E14S-7
J186			
P186	19	3	MS3108E14S-7S
J4015	15	6	MS3102E22-15
P4015	15	6	MS3106E22-15
J4017	14	48	GP3102E36-10
P4017	14	48	MS3106E36-10
J4018	14	48	GP3102E36-10
P4018	14	48	MS3106E36-10
J4019	14	47	GP3102E36-7
P4019	14	47	MS3106E36-7
J4020	14	47	GP3102E36-7P
P4020	14	47	MS3106E36-7S
J4029	15	47	GP3102E36-7
P4029	15	47	MS3106E36-7
J4031	15	24	GP3102E24-28S
P4031	15	24	MS3106E24-28
J4033	15	19	GP3102E22-14S
P4033	15	19	MS3106E22-14P
J4034	15	5	MS3102E14S-5P
P4034	15	5	MS3106E14S-5S
J4035	14	17	GP3102E20-29
P4035	14	17	MS3106E20-29
J4042			
P4042	39	2	MS3106E12S-3
J4037	14	48	GP3102E36-10S
P4037	14	48	MS3106E36-10
J4078			
P4078	30	2	MS3106E10SL-4S
P4090	35	8	MS3106E20-7S
P4091	18	8	MS3106E20-7S
P4092	20	8 CONTACTS	MS3106E20-7S

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CONNECTORS

ITEM NO	LOC	DESC	PART NO	MFGR	SPEC
2	15	4 CONTACTS	MS3102E20-4P	BENDIX	MIL-C-5015
2	15	4	MS3106E20-4S		
	15	4			
	15	4	MS3108E14S-2S(XLR79-NA-11)		
4	15	7	MS3102E24-10P		
4	15	7	MS3106E24-10S		
5	15	7	MS3102E24-10S		
5	15	7	MS3106E24-10P		
6	15	7	MS3102E24-10P		
6	15	7	MS3106E24-10S		
7	15	6	MS3102E20-22S		
7	15	6	MS3106E20-22P		
8	15	6	MS3108E20-22P		
8	15	6	MS3106E20-22S		
	15	6	MS3102E20-22S		
9	15	6	MS3106E20-22P		
	15	6	GP3102E20-22P		
	15	6	MS3106E20-22S		
	15	37	GP3102E28-21S		
	15	37	MS3106E28-21P		
	15	37	MS3102E28-21P		
2	15	37	MS3106E28-21S		
	14	3	MS3108E14S-7S		
	14	3	MS3106E14S-7S		
	19	3	MS3108E14S-7S		
	15	6	MS3102E22-15S		
	15	6	MS3106E22-15P		
	14	48	GP3102E36-10S		
	14	48	MS3106E36-10P		
	14	48	GP3102E36-10P		
	14	48	MS3106E36-10S		
	14	47	GP3102E36-7SW		
	14	47	MS3106E36-7PW		
	14	47	GP3102E36-7P		
	14	47	MS3106E36-7S		
	15	47	GP3102E36-7S		
	15	47	MS3106E36-7P		
	15	24	GP3102E24-28S		
	15	24	MS3106E24-28P		
	15	19	GP3102E22-14S		
	15	19	MS3106E22-14P		
	15	5	MS3102E14S-5P		
	15	5	MS3106E14S-5S		
	14	17	GP3102E20-29S		
	14	17	MS3106E20-29P		
	39	2	MS3106E12S-3S		
	14	48	GP3102E36-10S		
	14	48	MS3106E36-10P		
	30	2	MS3106E10SL-4S		
	35	8	MS3106E20-7S		
	18	8	MS3106E20-7S		
	20	8 CONTACTS	MS3106E20-7S	BENDIX	MIL-C-5015

CONNECTORS

ITEM NO	LOC	DESC	PART NO	MFGR	SPEC
J13	15	16 CONTACT	16 72-74124-7P	17 500709-61	MIL-S-5015
P13	15	16	MS3108E24-7S		
J14	15	6	16 72-74120-17P	17 500709	
P14	15	6	MS3108E20-17S		
J15	15	14	16 72-74120-27S	17 500709-11	
P15	15	14	MS3108E20-27P		
J16	14	47	MS3102E36-7S		
P16	14	47	MS3108E36-7P		
J18	15	19	16 72-74122-14S	17 500709-51	
P18	15	19	MS3108E22-14P		
J20	14	47	MS3102E36-7P		
P20	14	47	MS3108E36-7S		
J25	14	14	MS3102E20-27S		
P25	14	14	MS3108E20-27P		
J26		2			
P26	14	2	MS3108E10SL-4S		
J27		3			
P27	14	3	MS3108E10SL-3S		
J28		4			
P28	14	4	MS3106E16-9S (AD414-10[illegible]-0001) XLR79-NA-9 (XLR79-[illegible]-11)		
J29		2			
P29	15	2	MS3108E12S-3S		
J30		4			
P30	14	4	MS3108E14S-2S		
J31		2			
P31	15	2	MS3108E12S-3S		
J32		3			
P32	13	3	MS3108E10SL-3S		
J33		3			
P33	14	3	SC06E10SL-3S(FCB)		
J35		3			
P35	14	3	MS3108E14S-7S		
J39		3			
P39	14	3	SC06E-10SL-3S(FCB)		
J42		2			
P42	15	2	MS3108E12S-3S		
J44		3			
P44	13	3	MS3108E14S-7S		
J45		3			
P45	13	3	MS3108E14S-7S		
J47		2			
P47	15	2	MS3108E12S-3S		
J49		3			
P49	13	3	MS3108E10SL-3S		
J50		4			
P50	14	4	MS3108E14S-2S		
J56		4			
P56	14	4	MS3108E16-9S		
J70		4			
P70	14	4	MS3108E16-9S ([illegible]) XLR79-NA-9 ([illegible])		
P76	14	10	MS3106E18-1P		
P76	14	10	MS3108E18-1S		
P79	14	10	MS3106E18-1P		
P79	14	10	MS3108E18-1S		
J92		3			
P92	13	3	MS3106E10SL-3S		
J4101	49	5	MS3102E18-11P		
P4101	49	5	MS3106E18-11S		
J4102	49	31	MS3102E36-9S		
P4102	49	31	MS3106E36-9P		
	49	3 CONTACT	MS3106E10SL-3S		MIL-S-5015

33. C
32. C
31. R
30. A
29 C
28. C
27. C
P
19 26. C
CU
18 25. M
RE
16 17 24. C
RE
15 23. P
14 22. P
13 21. P
12 20. P
11 19. C
10 18. C
9 17. C
8 16. C

4

3

35

ZONE	
3,17 & 28	F
3 & 41	G
3, 10, & 23	H
19,22 & 38	J
21	K

33. CIRCUITRY TO BE ADDED FOR MB3-161 (G1000 MD 6)
32. CIRCUITRY TO BE ADDED FOR MB3-160 (G1000 MD 15)
31. REMOVED PER MB3-149
30. ADDED PER MB3-149
22 29. CIRCUITRY TO BE ADDED FOR MB3-144 (G1000 MD14)
21 28. CIRCUITRY TO BE REMOVED FOR MB3-144 (G1000 MD14)
27. CIRCUITRY TO BE INSTALLED FOR HYBRID ENGINE FIRING (G1000MD13 & G3000 MD17)
19 26. CIRCUITRY TO BE INSTALLED FOR LOX VALVE MONITOR CUTOFF (G1000 MD12 & G3002 MD5)
18 25. MV7002 RELAYS REPLACED ON ALL ENGINE RELAY BOXES BY NAS-27103 TYPE I RELAYS
16 17 24. CONNECTORS CODED 16 REPLACED ON ALL ENGINE RELAY BOXES BY CONNECTORS CODED 17
15 23. PINS a, e, c, g, V, W & R ARE BUSSED TOGETHER IN J20 INTERNALLY
14 22. PINS y, v, A, P, s & m ARE BUSSED TOGETHER IN J20 INTERNALLY
13 21. PINS x, u, t, n, d & k ARE BUSSED TOGETHER IN J20 INTERNALLY
12 20. PINS D, E, F, G & M ARE BUSSED TOGETHER IN J25 INTERNALLY

NAA ONLY

11 19. CIRCUITRY TO BE ADDED FOR MB3-19. (G1000 MD11)
10 18. CIRCUITRY TO BE REMOVED FOR MB3-19 (G1000MD11)
9 17. CIRCUITRY TO BE ADDED FOR MB3-24 (G1000 MD10)
8 16. CIRCUITRY TO BE REMOVED FOR MB3-24 (G1000 MD10)

7 15. CIRCUITRY TO BE ADDED FOR START TANKS PRESSURIZING CUT-OFF, GROUND POWER FAILURE CUT-OFF & SEPARATION OF MISSILE & G100
6 14. CIRCUITRY TO BE REMOVED FOR START TANKS PRESSURIZING CUT-OFF, GROUND POWER FAILURE CUT-OFF & SEPARATION OF MISSILE & G100
5 13. CIRCUITRY TO BE ADDED FOR LAUNCH LOCKOUT. (G1000MD6 & UP)
4 12. CIRCUITRY TO BE REMOVED FOR LAUNCH LOCKOUT (G1000MD6 & UP)
3 11. CIRCUITRY TO BE ADDED FOR RESET OF XLR 79-NA-7 (G1000MD4 & UP)
2 10. CIRCUITRY TO BE REMOVED FOR STATIC FIRING. (G1000MD5)*
1 9. CIRCUITRY TO BE INSTALLED FOR STATIC FIRING. (G1000MD5, G3002MD5
8. UNDERLINED CONNECTOR PIN LETTERS DENOTE LOWER CASE.
7. REF DWG 900040 SCHEMATIC,
6. REF DWG 900075 BLOCK DIAGRAM
5. SYMBOL ⬡ INDICATES RECORDER CONNECTIONS
4. REF DWG SCHEMATIC NO. 902500 FOR ENGINE SIMULATOR
3. SYMBOL D DENOTES DOUGLAS AIRCRAFT COMPANY CONNECTIONS.
2. WIRES ARE #20 AWG FOR ALL PANELS & WIRES ARE #16 AWG FOR ALL CABLES
1. THE COMPLETE REFERENCE SYMBOL DESIGNATION FOR CONNECTORS IS IN 4000 SERIES (EXAMPLE: J37 IS J4037) EXCEPT THOSE IN ENGINE RELAY BOX, ENGINE JUNCTION BOX, & ENGINE ACCESSORY SECTION.

NOTE: UNLESS OTHERWISE SPECIFIED

DRIL... TOL...
.0135 TO
.136 TO
.334 TO
.516 TO
.766 TO
1.016 TO

3

2

36

ZONE	SYM	DESCRIPTION		ECP / DATE
3, 17 & 28	F	1. ADDED NOTE 26 & CIRCUITRY FOR LOX VALVE MONITOR CUTOFF	3	ECP MB3-67 4-14-60
3 & 41	G	1. ADDED NOTE 27 & CIRCUITRY FOR HYBRID ENGINE FIRING	3	ECP MB3-103 3-22-61 J. Cooper
3, 10, & 23	H	1. ADDED NOTE 28 & 29 & CIRCUITRY FOR FLIGHT LOCK-IN CIRCUIT	3	ECP MB3-144 8-13-62
19, 22 & 38	J	1. ADDED NOTE 30 & 31, CODE & CIRCUITRY FOR FLIGHT LOCK-IN CIRCUIT	3	ECP MB3-149 B.J. LUCAS 11-14-62
21	K	1. ADDED NOTE 32 & 33, CODE & RECORDING CIRCUIT THROUGH CONTROL MONITOR	3	ECP MB3-160 ECP MB3-161 12/13/62 SVOREN

REVISIONS

1 MAY BE REWORKED 2 CANNOT BE REWORKED 3 RECORD CHANGE 4 NOW SHOP PRACTICE 5 PARTS MADE OK

ZONE	SYM	DESCRIPTION	D	DATE	SIGNATURE
	A				
17 & 18		1. ADDED PROP TRANSFER HOLD CUT-OFF CIRCUITRY	3		
35		2. ADDED K91-C2 CONTACTS	3		
19		3. ADDED PROP DEPLETION CUT-OFF, SLOW BUILD-UP CUT-OFF, HIGH TEMPERATURE CUT-OFF	3	11-1-58	ECP 9310-131 B BEATTIE ECP 9310-132
	B				
19, 45		1. ADDED RESET CIRCUITRY	3		ECP 9310-137
		2. ADDED RELAY K17-C2. NOTE 11.	3		ECP 9310-137
27		3. CHANGED LAUNCH LOCKOUT CIRCUITRY	3		ECP 9310-147
		4. ADDED NOTES 12 & 13	3		ECP 9310-147
35		5. RELAY K44-C T.D.P.U. 2.5 SEC. WAS 1.5 SEC.	3	1-5-59	B BEATTIE
	C				
		1. ADDED NOTES 14 & 15	3	ECP MB3-6	
		2. ADDED COMPONENTS LIST FOR ENGINE RELAY & JUNCTION BOX	3		
40, 45		3. ADDED CONTROL-INDICATOR LUB. TANK HEATER CIRCUITRY	3	ECP MB3-15	
		4. ADDED AUXILLARY PNEUMATIC TEST PNL CIRCUITRY	3	5-22-59	
	D				
		1. ADDED NOTES 16 & 17; & RELATED CIRCUITRY	3	ECP MB3-24	
		2. ADDED NOTES 18 & 19; & RELATED CIRCUITRY	3	ECP MB3-19 9-30-59	
	E				
		1. ADDED NOTES 20, 21, 22 & 23; & RELATED CIRCUITRY	3	ECP MB3-40	
		2. 501C81 WAS 500396	3	ECP MB3-40	
		3. ADDED NOTES 24 & 25	3	ECP 5536-77	
		4. 500352-11 WAS 500352	3	ECP 5536-77	
		5. ADDED SEQUENCE CHART	3		

...O BE ADDED FOR START TANKS PRESSURIZING
...ND POWER FAILURE CUT-OFF & SEPARATION OF MISSILE & G1000 BUSES (G1000MD7 & UP)
...O BE REMOVED FOR START TANKS PRESSURIZING
...ND POWER FAILURE CUT-OFF & SEPARATION OF MISSILE & G1000 BUSES (G1000MD7 & UP)
...O BE ADDED FOR LAUNCH LOCKOUT. (G1000MD6 & UP)
...O BE REMOVED FOR LAUNCH LOCKOUT (G1000MD6 & UP)
...O BE ADDED FOR RESET OF XLR 79-NA-7 (G1000MD4 & UP)
...O BE REMOVED FOR STATIC FIRING. (G1000MD5)*
... BE INSTALLED FOR STATIC FIRING. (G1000MD5, G3002MD3)
... CONNECTOR PIN LETTERS
...OWER CASE.
...00040 SCHEMATIC,
...00075 BLOCK DIAGRAM
...NDICATES RECORDER CONNECTIONS
...HEMATIC NO. 902500 FOR
...MULATOR
...ENOTES DOUGLAS AIRCRAFT
...ONNECTIONS.
...#20 AWG FOR ALL PANELS &
...#16 AWG FOR ALL CABLES
...TE REFERENCE SYMBOL DESIG-
... CONNECTORS IS IN 4000 SERIES
...37 IS J 4037) EXCEPT THOSE IN
...Y BOX, ENGINE JUNCTION BOX,
...CESSORY SECTION.
...OTHERWISE SPECIFIED

FOR REFERENCE ONLY

DRILLED HOLE TOLERANCES
.0135 TO .1285 +.002, −.001
.136 TO .250 +.003, −.001
.254 TO .500 +.004, −.001
.516 TO .750 +.005, −.001
.766 TO 1.000 +.007, −.001
1.016 TO 2.000 +.010, −.001

DIMENSIONS PRIOR TO FINISH. TOLERANCES EXCEPT AS NOTED XXX=±.010, XX=±.03, ANGLES=±½°

125 MACH. SURF. ROUGHNESS EXCEPT AS NOTED (PER MIL-STD-10)

HEAT TREAT PER

FINISH

DATE 7-23-58 DWN BEATTIE CK BEATTIE STR. MAT'L

SCHEMATIC-ENGINE ELEC SYSTEM

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.
6633 CANOGA AVE, CANOGA PARK, CALIFORNIA

SCALE NONE WT

DWG SIZE J 900100

900100

2

OPERATING REQUIREMENTS AND LIMITATIONS

Frequently reviewed specifications and limitations applicable to operation of the LV-2A propulsion system are contained in this section.

FUEL PUMP INLET (RJ-1)

The minimum required NPSH for starting at 0 to 120 F is 80 feet. The minimum required NPSH for nominal rated thrust operation at 0 to 120 F is 34 feet. The maximum allowable surge pressure at 0 to 120 F is 160 psig.

OXIDIZER PUMP INLET

At saturation temperature, (1) the minimum required net positive suction head (NPSH) for starting is 55 feet, (2) the minimum NPSH required for nominal rated thrust operation is 55 feet, and (3) the maximum allowable surge pressure is 160 psig.

GROUND AND FLIGHT LOADING CONDITIONS

Handling Load

The main and vernier engines shall withstand a maximum of 4 g handling loads applied in any direction.

Flight Operation

The engine system shall operate satisfactorily without permanent deformation or failure under the following specified loads:

1. Load of 15 g parallel to the direction of flight and 1 g perpendicular to the direction of flight
2. Load of 12 g parallel to the direction of flight and 1.25 g perpendicular to the direction of flight
3. Load of 10 g parallel to the direction of flight and 1.5 g perpendicular to the direction of flight
4. Load of 2.5 g parallel to the direction of flight and 3 g perpendicular to the direction of flight

Critical Customer Connect Point Maximum Loading

The customer connect point maximum loading is as follows:

Attach Point*		Allowable Loads
Mount Attach to Missile (Pt. 1)	F_y =	63,000 lb 5930-lb side load
Mount Attach to Missile (Pt. 2)	F_y =	63,000 lb 5930-lb side load
Mount Attach to Missile (Pt. 3)	F_y =	63,000 lb 5930-lb side load
LOX Inlet Duct	F_y =	3,200 lb
Fuel Inlet Duct	F_y =	7,200 lb
Actuator Attach Point		±10,000 lb axial force
Aft End of Heat Exchanger		300 lb any direction
Forward Attach Lug Heat Exchanger		380 lb any direction
Aft Attach Lug Heat Exchanger	F_y =	±380 lb
	F_x =	± 50 lb
	F_z =	±380 lb
Main Oil Discharge		100 lb any direction
LOX Seal Drain		50 lb any direction
Oil Seal Drain		50 lb any direction

*Refer to coordinate system

PNEUMATIC SUPPLY

The pneumatic supply as delivered to the main engine manifold will be MIL-N-6011 nitrogen, liquid and gas. The flows quoted are for the propulsion system requirements only. No allowance has been made for other applications.

1. Standby: high-pressure nitrogen, 0.150 lb/min maximum is required at 3000 to 1000 psi for oxidizer pump seal purge and the engine control system bleed and leakage. Nitrogen temperature range is -65 to +160 F.
2. Starting: high-pressure nitrogen, 4.0 lb maximum is supplied at 3000 to 1500 psi and at a temperature range of -65 to +160 F for oxidizer pump seal purge, engine start tank pressurization, and pneumatic control.
3. Flight operation: high-pressure nitrogen, 2.0 lb maximum is supplied at 3000 to 800 psia and at a temperature range of -65 to +160 F for oxidizer pump seal purge, controls, and engine lubrication tank pressurization. Maximum flowrate is 0.0115 lb/sec.
4. Vernier engine solo flight: high-pressure nitrogen, 8.0 lb maximum is supplied at 3000 to 800 psia and at a temperature range of -65 to +160 F for vernier tank pressurization and pneumatic control. Maximum flowrate is 0.89 lb/sec.

The regulated pneumatic pressure at the customer supply connect-point is 660 psia.

A nitrogen supply temperature of 70 F was assumed for the above computations.

SECTION II: PROPULSION SYSTEM PERFORMANCE

STEADY-STATE PERFORMANCE

Steady-state performance values presented in this section were obtained from production engine test results. Run-to-run deviations include random instrumentation errors and run-to-run nonrepeatability. The actual component differences are depicted in the engine-to-engine deviations.

RATED MAIN ENGINE PERFORMANCE

The main engine nominal performance values and attendant variations at sea-level standard temperature and pressure, rated thrust and rated mixture ratio appear in Table 5 . The vernier performance values were analytically determined using a typical vernier system downstream of the customer connect points. Since vernier performance depends upon the pressure supplied by the main engine, it will not exactly agree with rated values obtained from vernier production testing. A performance schematic depicting relative positions of flow and pressure data is presented in Fig. 6 .

Run-to-run deviations in engine thrust and mixture ratio, and run-to-run and engine-to-engine deviations in specific impulse for the main engine are presented in Table 6 .

Information regarding effects of nitrogen dilution on engine performance is included for application for analysis in the event of a suspected occurrence. Performance shifts of sea-level engine specific impulse and thrust due to nitrogen dilution of LOX presented in Fig. 7 and 8 were based on test results conducted on an engine system other than, but considered sufficiently descriptive of, the Thor. Empirically determined effects on c*, C_F, gas generator temperature and LOX density due to nitrogen dilution were imposed on nominal engine data to generate the figures.

TABLE 5

NOMINAL MAIN ENGINE PERFORMANCE VALUES
AT SEA-LEVEL RATED THRUST AND MIXTURE RATIO

Parameter	Nominal Value	Standard Deviation: Engine-to-Engine (S_{EE})	Standard Deviation: Run-to-Run (S_{RR})
Engine			
Oxidizer (LOX) Density, lb/cu ft	71.38*		
Fuel (RJ-1) Density, lb/cu ft	53.17*		
Thrust, pounds	170,000*	---	---
Specific Impulse, seconds	252.4	0.62	0.30
Mixture Ratio (o/f), including vernier flow	2.15*	---	---
Thrust Chamber			
Thrust, pounds	169,500	---	---
Specific Impulse, seconds	257.5	0.62	0.31
Characteristic Velocity (c*), injector end, ft/sec	5958	15.4	9.5
Thrust Coefficient (C_F), injector end	1.391	0.0038	0.0021
Chamber Pressure, injector end, psia	594.3	1.53	0.92
Characteristic Velocity, nozzle stagnation, ft/sec	5517.	---	---
Thrust Coefficient, nozzle stagnation	1.502	---	---
Chamber Pressure, nozzle stagnation, psia	550.3	---	---
c* Efficiency, %	95.5	0.25	0.15
C_F Efficiency, %	101.2	0.25	0.15
Propellant Flowrates, lb/sec			
Oxidizer	456.3	1.11	0.54
Fuel	201.9	0.48	0.26
Mixture Ratio (o/f)	2.260	0.0016	0.0008
Main Fuel Orifice Pressure Drop, psi	55.6		
at 190 lb/sec and 53.17 lb/cu ft	49.2	10.3	1.8
Orifice Diameter, inches	2.74		

TABLE 5

(Continued)

Parameter	Nominal Value	Standard Deviation Engine-to-Engine (S_{EE})	Standard Deviation Run-to-Run (S_{RR})
Propellant Pumps			
LOX Pump			
Inlet Pressure (total), psia	53.0*	---	---
Discharge Pressure (total),psia	862.	14.8	2.9
Developed Head, feet	1641.	11.8	6.7
Weight Flow, lb/sec	469.9	1.14	0.56
Volume Flow, gpm	2955.	7.2	3.5
Speed, rpm	6252.	26.8	8.4
Shaft Power, bhp	1772.	16.2	8.6
Efficiency, %	79.1	---	---
Fuel Pump			
Inlet Pressure (total), psia	48.0*	---	---
Discharge Pressure (total), psia	902.	14.8	2.9
Developed Head, feet	2307.	39.8	7.8
Weight Flow, lb/sec	217.2	0.53	0.26
Volume Flow, gpm	1833	4.50	2.18
Speed, rpm	6252.	26.8	8.4
Shaft Power, bhp	1272.	22.0	5.24
Efficiency, %	71.6	---	---
Turbine			
Turbine Shaft Power, bhp	3136.	31.	13
Turbine Inlet Temperature, F	1203.	10.6	3.0
Turbine Gas Flow, lb/sec	15.21	0.16	0.05
Turbine Exhaust Pressure (static), psia	23.6	1.69	0.25
Turbine Inlet Pressure (total),psia	515.6	4.8	2.3
Turbine Pressure Ratio (total psia inlet/static exhaust)	21.8	---	---

TABLE 5
(Continued)

Parameter	Nominal Value	Standard Deviation: Engine-to-Engine (S_{EE})	Standard Deviation: Run-to-Run (S_{RR})
Gas Generator			
Gas Generator Chamber Pressure, injector end, psia	541.4	5.5	1.6
LOX Bleed Pressure, psia	788.	----	----
Fuel Bleed Pressure, psia	888.	----	----
Total Propellant Flow **, lb/sec	15.21	0.16	0.05
LOX Flow**, lb/sec	3.73	0.04	0.01
Fuel Flow**, lb/sec	11.48	0.14	0.04
Mixture Ratio (o/f)	0.325	0.004	0.001
Fuel Orifice Pressure Drop, psi	167.3	----	----
at 10.5 lb/sec and 53.17 lb/cu ft	139.9	----	----
Orifice Diameter, inch	0.530		
LOX Orifice Pressure Drop, psi	86.3	---	----
at 3.5 lb/sec and 71.38 lb/cu ft	75.9	14.5	1.3
Orifice Diameter, inch			
Verniers (Pump-Fed)			
LOX Flow, lb/sec	6.56	0.054	0.019
Fuel Flow, lb/sec	3.61	0.035	0.011
Vernier Total Flow, lb/sec	10.17	0.070	0.026
Mixture Ratio (o/f)	1.82	0.019	0.006
LOX Customer Connect Pressure, psia	762.	9.0	3.3
Fuel Customer Connect Pressure, psia	701.	7.9	2.6
Heat Exchanger LOX Flow, lb/sec	3.17	0.045	0.046

TABLE 5
(Continued)

Parameter	Nominal Value	Standard Deviation: Engine-to-Engine (S_{EE})	Standard Deviation: Run-to-Run (S_{RR})
Verniers (Solo)			
LOX Flow, lb/sec	5.38	0.028	0.014
Fuel Flow, lb/sec	3.01	0.018	0.006
Vernier Total Flow, lb/sec	8.39	0.046	0.020
Mixture Ratio (o/f)	1.78	0.007	0.006
LOX Customer Connect Pressure, psia	575.	4.40	2.1
Fuel Customer Connect Pressure, psia	530.	4.20	1.20
Engine Regulator Pressure Setting, psia	660.	----	----

NOTE: All pressures were measured with a static tap, unless designated as total. Pressure designated as total were calculated from a static measurement.

* Rated value
**Calculated from turbine inlet temperature and pressure

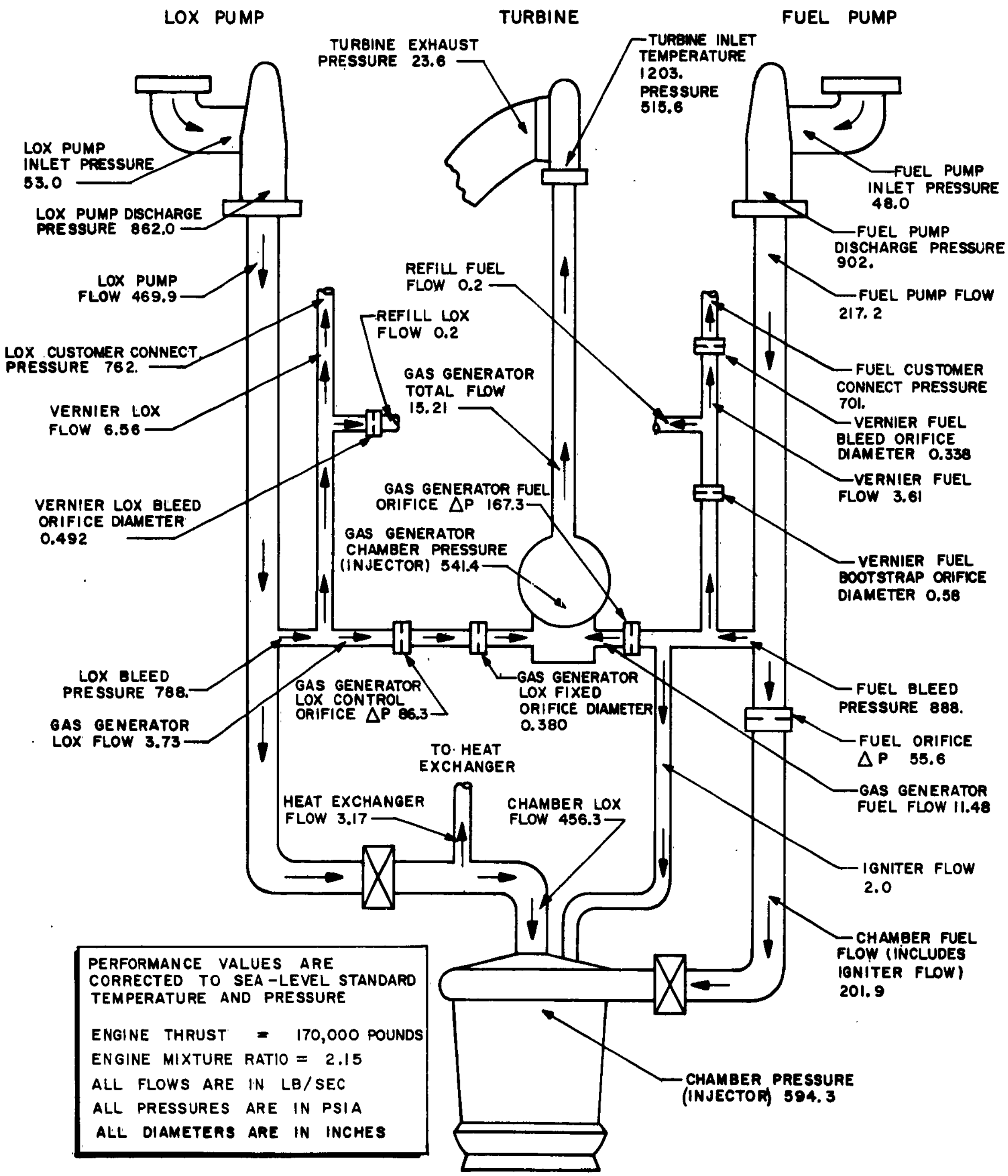


Figure 6. Main Engine Performance Schematic

TABLE 6

PERFORMANCE DEVIATIONS, YLR79-NA-13 THOR MAIN ENGINES
(Data Based on 47 Runs Involving 23 Engines)

Parameter	Specified or Mean Value	Deviation, %
<u>Engine Thrust</u>		
Specified, pounds	170,000 ±3%	
Run-to-Run Deviation*		0.25
Run-to-Run, 95% Tolerance		0.61
<u>Mixture Ratio</u>		
Specified	2.15 ±1.02%	
Run-to-Run Deviation*		0.23
Run-to-Run, 95% Tolerance		0.56
<u>Specific Impulse**</u>		
Specified Minimum, seconds	249.	
Mean	252.4	
Run-to-Run Deviation*		0.12
Run-to-Run, 95% Tolerance		0.29
Engine-to-Engine Deviation		0.25
Engine-to-Engine, 95% Tolerance		0.61
Over-all Standard Deviation***		0.27
Over-all, 95% Tolerance		0.63

* Run-to-run standard deviation

** Specific impulse values are quoted at rated thrust and mixture ratio

***Run-to-run and engine-to-engine standard deviation. This method of combination allows a conservative estimation.

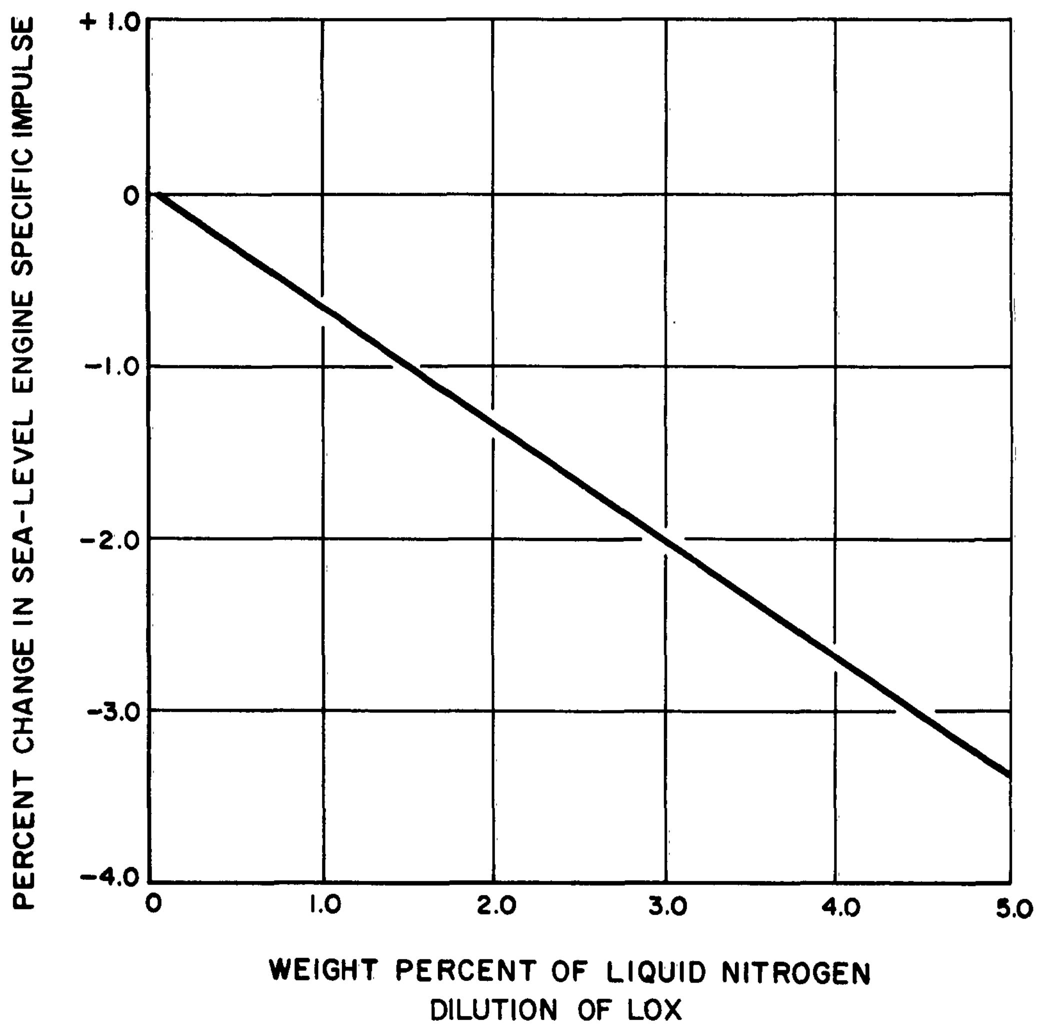


Figure 7. Effects of Liquid Nitrogen Dilution on Sea Level Engine Specific Impulse

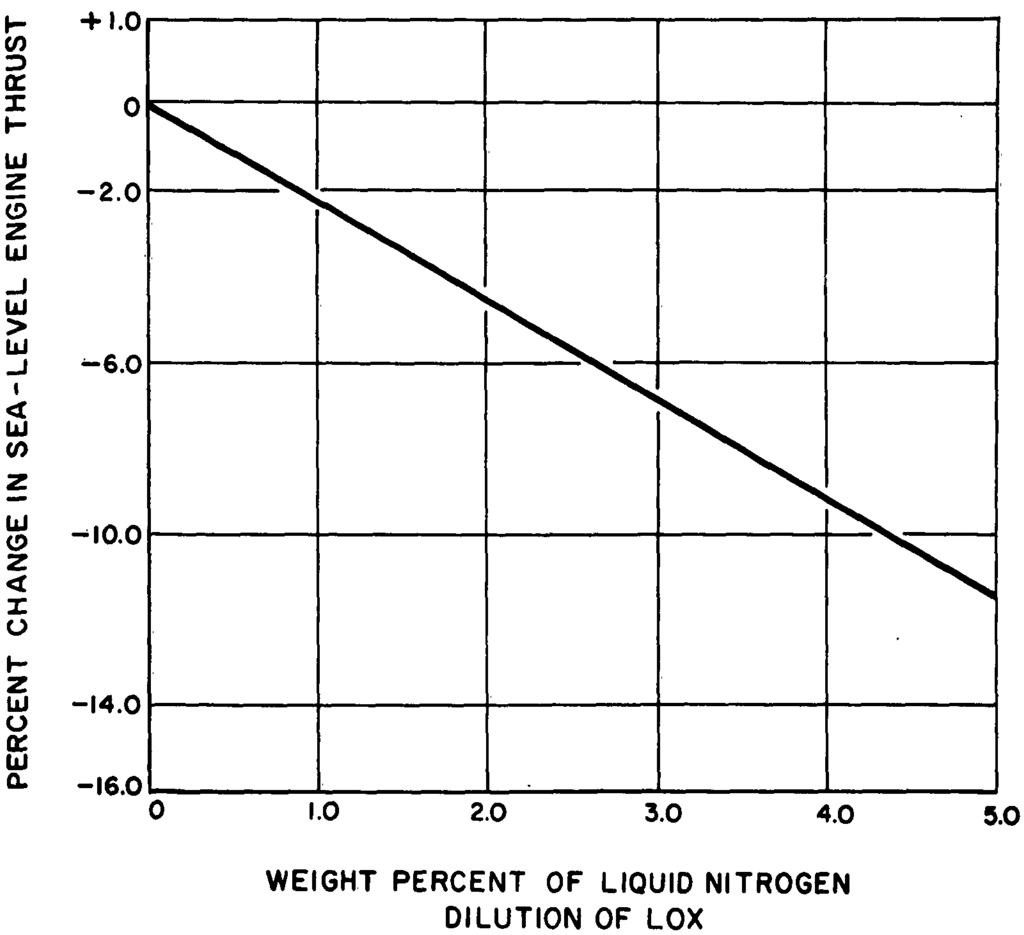


Figure 8. Effects of Liquid Nitrogen Dilution on Sea-Level Engine Thrust

RATED VERNIER ENGINE PERFORMANCE

Statistical analyses of LR101-NA-11 vernier engine data are presented in Table 7, covering mean performance, run-to-run, and engine-to-engine variations. The data are based on 94 tests on 47 acceptance engines. RP-1 was used for all tests. Data were reduced to sea-level standard temperature and pressure rated thrust, mixture ratio, and propellant inlet pressures prior to statistical analysis. The data reduction program computes orifices required to give rated thrust and mixture ratio at tank-fed conditions. With these orifices, the program then computes what thrust and mixture ratio would be under pump-fed conditions.

The following standard conditions are used by the data reduction program:

Rated Parameter	Tank-Fed	Pump-Fed
Thrust, pounds	830	---
Mixture Ratio	1.80	---
LOX Inlet Pressure, psia	540	660
Fuel Inlet Pressure, psia	510	636
LOX Specific Gravity, lb/cu ft	66.27	70.73
Fuel Specific Gravity, lb/cu ft	50.48	50.48

A schematic of vernier operation under pump-fed conditions (with RJ-1 fuel) appears in Fig. 9.

TABLE 7

NOMINAL LR101-NA-11 VERNIER ENGINE PERFORMANCE
AND PERFORMANCE DEVIATIONS

Parameter	Mean Value	S_{EE}	C_{VEE}	S_{RR}	C_{VRR}
Tank-Fed					
Specific Impulse, seconds	198.7	1.92	0.97	1.12	0.56
Characteristic Velocity (c*), Injector End, ft/sec	4942	69.9	1.41	29.1	0.59
Thrust Coefficient (C_F), Injector End	1.294	0.007	0.55	0.005	0.35
Chamber Pressure, Injector End, psia	305.4	2.64	0.86	0.85	0.28
Chamber Pressure, Nozzle, psia	298.	--	--	--	--
LOX Weight Flow, lb/sec	2.68	--	--	--	--
Fuel Weight Flow, lb/sec	1.49	--	--	--	--
LOX Orifice Differential Pressure, psi	39.8	7.96	20.0	2.97	7.44
Fuel Orifice Differential Pressure, psi	27.6	7.68	27.8	3.33	12.05
Pump-Fed					
Thrust, pounds	1017	5.64	0.55	4.19	0.41
Mixture Ratio	1.803	0.010	0.54	0.011	0.61
Specific Impulse, seconds	209.8	2.21	1.05	0.83	0.39
c*, Injector End, ft/sec	5054.	51.5	1.02	21.0	0.42
C_F, Injector End	1.336	0.005	0.39	0.005	0.37

TABLE 7
(Continued)

Parameter	Mean Value	S_{EE}	C_{VEE}	S_{RR}	C_{VRR}
Chamber Pressure, Injector End, psia	362.5	3.39	0.93	1.70	0.47
Chamber Pressure, Nozzle, psia	353.	- -	- -	- -	- -
LOX Weight Flow, lb/sec	3.12	- -	- -	- -	- -
Fuel Weight Flow, lb/sec	1.73	- -	- -	- -	- -

S_{EE} Engine-to-engine standard deviation

C_{VEE} Engine-to-engine coefficient of variation (standard deviation expressed as percentage of the mean)

S_{RR} Run-to-run standard deviation

C_{VRR} Engine-to- engine coefficient of variation (standard deviation expressed as percentage of the mean)

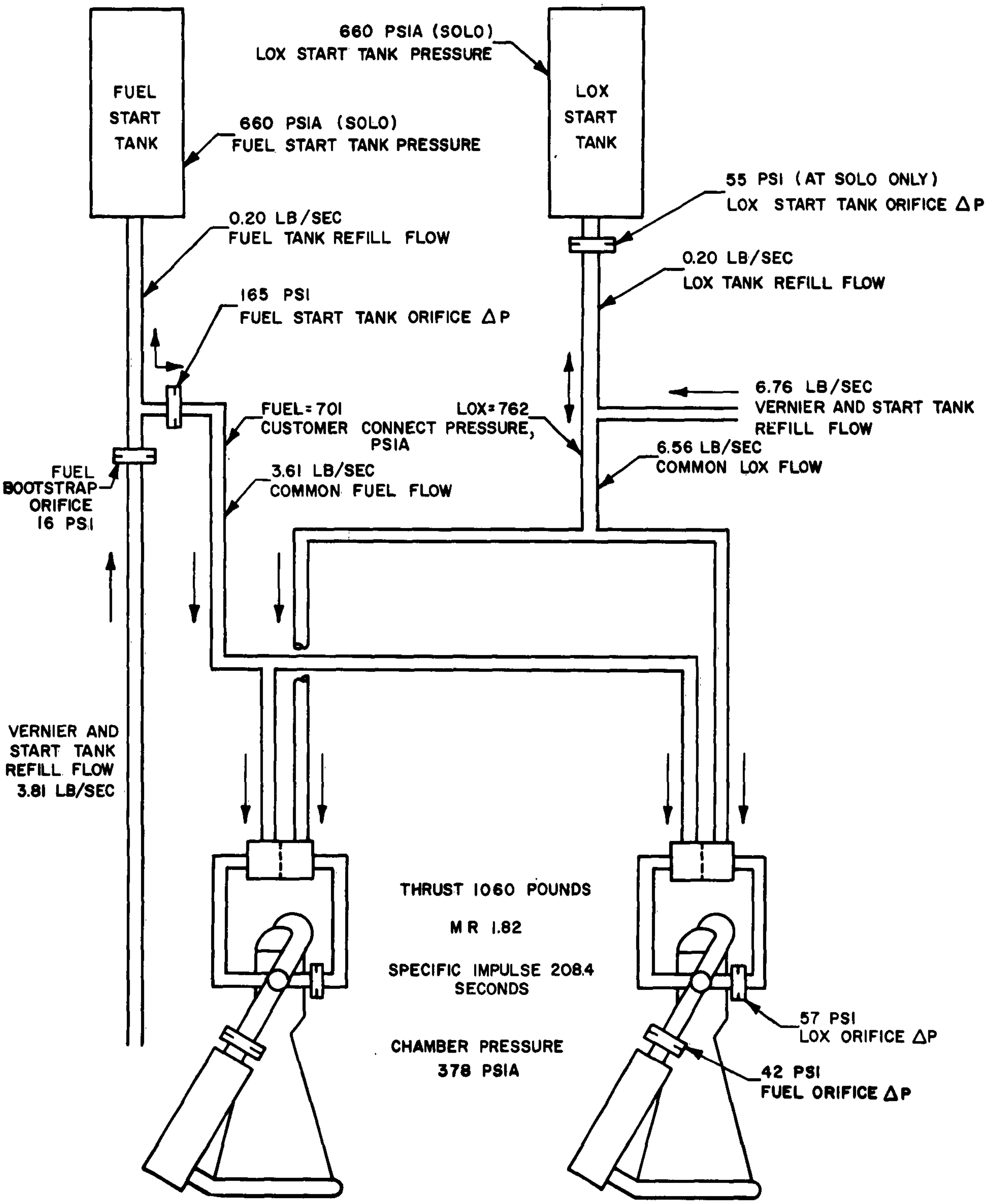


Figure 9. LR79-NA-11 Vernier Pump-Fed Performance Schematic

INFLUENCE COEFFICIENTS

LINEARIZED SOLUTIONS

Engine influence coefficients result from a linearized solution of a set of steady-state equations which describe the operation of an engine. Each influence coefficient is expressed in percentage from, and represents the effect that a 1% increase in an engine independent variable will have on an engine dependent variable. A coefficient preceded by a positive (+) sign (or no sign) indicates that an increase in the independent variable results in an increase in the dependent variable; a coefficient preceded by a negative (-) sign indicates that an increase in the independent variable results in a decrease in the dependent variable.

ILLUSTRATION

Figure 10 is a portion of a typical table of engine influence coefficients. This table is in the form as printed by a high-speed digital computer. The symbols E 01, E 04, etc., placed after the nominal values in the table represent powers of 10. Hence 1.4696E 01 is equivalent to 14.696; 6.0000E 04 is equivalent to 60,000; etc.

APPLICATION

These influence coefficients may be applied to two different situations; (1) calculations involving an engine type, or (2) calculations involving a specific engine.

A ONE-PERCENT INCREASE IN ANY ONE OF THE INDEPENDENT VARIABLES CAUSES THE FOLLOWING PERCENTAGE CHANGE IN ANY ONE OF THE DEPENDENT VARIABLES.

-INDEPENDENT VARIABLES-

1. ATMOSPHERIC PRES - - - - - - 1.4696E 01
2. FUEL DENSITY - - - - - - - - 5.0450E 01
3. OXID DENSITY - - - - - - - - 7.1380E 01
4. FUEL PUMP INLET PRES - - - - 7.7000E 01
5. OXID PUMP INLET PRES - - - - 5.3000E 01
6. C* CORRECTION - - - - - - - - - - - - -

-DEPENDENT VARIABLES-	1-	2-	3-	4-	5-	6-
ENGINE THRUST - - 6.0000E 04	-0.4556	0.5326	0.0703	0.0576	0	0.6494
ENGINE ISP - - - 2.3000E 02	-0.4426	0.1462	0.0341	0.0182	0	1.1677
ENGINE MR - - - - 2.2700E 00	-0.0039	-0.4054	0.3016	0.0200	0	-0.4134
ENGINE FUEL FLOW- 7.9770E 01	-0.0096	0.6588	-0.1688	0.0243	0	-0.2268
ENGINE OXID FLOW- 1.8110E 02	-0.0145	0.2674	0.1256	0.0461	0	-0.6462

Figure 10 . Sample Table of Influence Ceofficients as Printed by High-Speed Digital Computer

Calculations Involving an Engine Type

Suppose it were desired to determine the thrust of the engine described by the sample table of influence coefficients when operated under the following conditions:

1.	Atmospheric pressure	=	1.40 psia
2.	Fuel density	=	50.45 lb/cu ft
3.	Oxidizer density	=	69.55 lb/cu ft
4.	Fuel pump inlet pressure	=	69.30 psia
5.	Oxidizer pump inlet pressure	=	59.55 psia

Because the influence coefficients are linear, the total effect of several influences acting simultaneously on an engine can be determined by adding the individual effects of each influence. The change in engine thrust would be

$$\frac{F_E - F_{E_i}}{F_{E_N}} = \frac{P_a - P_{a_i}}{P_{a_N}} (F_{P_a}) + \frac{\rho_F - \rho_{F_i}}{\rho_{F_N}} (F_{\rho_F}) + \frac{\rho_o - \rho_{o_i}}{\rho_{o_N}} (F_{\rho_o}) + \frac{P_F - P_{F_i}}{P_{F_N}} (F_{P_F}) + \frac{P_o - P_{o_i}}{P_{o_N}} (F_{P_o}), \tag{1}$$

Where F_E, P_a, ρ_F, ρ_o, etc., are the actual values of these parameters for the problems considered.

F_{E_i}, P_{a_i}, ρ_{F_i}, ρ_{o_i}, etc., are the initial or base values of these parameters.

F_{E_N}, P_{a_N}, ρ_{F_N}, ρ_{o_N}, etc., are the nominal values of these parameters, listed in the table of influence coefficients.

F_{P_a}, F_{ρ_F}, F_{ρ_o}, etc., are the influence coefficients for engine thrust found in the appropriate columns of the table of influence coefficients.

For calculations involving an engine type, the initial values would be the same as the nominal values, and $F_{E_i} = F_{E_N}$, $P_{a_i} = P_{a_N}$, $\rho_{F_i} = \rho_{F_N}$, $\rho_{o_i} = \rho_{o_N}$, etc.

The calculation for the example stated above would be as follows:

$$\frac{F_E - 60{,}000}{60{,}000} = \left(\frac{1.40 - 14.696}{14.696}\right)(-0.4556) + \left(\frac{50.45 - 50.45}{50.45}\right)(+0.5326)$$

$$+ \left(\frac{69.55 - 71.38}{71.38}\right)(+0.0703) + \left(\frac{69.30 - 77.00}{77.00}\right)(+0.0576)$$

$$+ \left(\frac{59.55 - 53.00}{53.00}\right)(0)$$

$$\frac{F_E - 60{,}000}{60{,}000} = -0.9047\,(-0.4556) + 0(+0.5326)$$

$$-0.0256\,(+0.0703) - 0.1000\,(+0.0576)$$

$$+0.1236\,(0) = +0.4046 \text{ or } +40.46\%$$

Therefore:

$$F_E = +0.4046\ (60{,}000) + 60{,}000$$

$$F_E = +24{,}276 + 60{,}000 = 84{,}276 \text{ pounds}$$

The incremental thrust change has been found to be +24,276 pounds for the conditions stated, yielding a final engine thrust of 84,276 pounds.

Calculations Involving a Specific Engine.

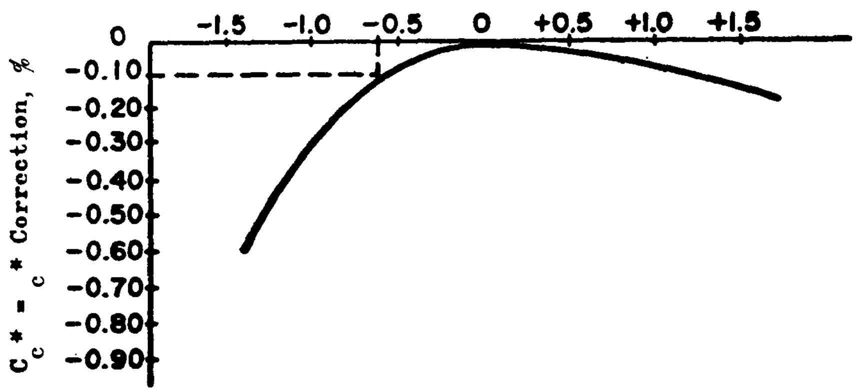
When the values of actual engine parameters differ from those used as nominal values in the table of influence coefficients, the "delta method" of application of influence coefficients is used. This procedure consists of computing an incremental change of variables rather than a percentage change of these variables. The incremental change is then applied to the actual engine value. This effect can be accomplished by using Eq. (1) if the quantities F_{E_i}, P_{a_i}, ρ_{F_i}, ρ_{o_i}, etc., are defined as the actual engine values of these parameters. All other quantities are as defined previously.

NONLINEAR CORRECTIONS

A special computational procedure has been devised to extend the usefulness of engine influence coefficients. This technique is used to allow nonlinear corrections to be made for certain parameters where the linear approximation is not sufficiently accurate. An example of this method is the c* correction (C_{c*}). In this case, a plot of C_{c*} vs the change in engine mixture ratio is included with the table of influence coefficients. Similarly, other nonlinear corrections would be applied as additional terms in the summation of effects.

A typical plot of these parameters is shown below:

$$\left(\frac{\mu_E - \mu_{E_N}}{\mu_{E_N}}\right)100 = \left(\frac{\text{Change in Engine Mixture Ratio}}{\text{Nominal Engine Mixture Ratio}}\right)100\%$$



The change in engine mixture ratio is computed for the changes in atmospheric pressure, propellant densities, etc., and with the assumption that the c* correction is zero. With this change in engine mixture ratio, the c* correction is read from the curve. This value of c* correction is used with the other independent variables to compute the changes in the remaining dependent variables.

For example, if the change in engine mixture ratio accompanying the +40.46% thrust change in the preceding example were -0.62%, then the c* correction from the curve is -0.10%. The true change in engine thrust is therefore:

(% change in F_E = +40.46 - 0.10 (+0.6494) = +40.40%)

Similarly, other nonlinear corrections would be applied as additional terms in the summation of effects.

LV-2A INFLUENCE COEFFICIENTS

Current influence coefficients for the LV-2A propulsion system are presented in Tables 8 and 9. Table 8 includes the additional effect of fuel temperature on system performance while considering fuel density a constant. Any density change, therefore, is considered independently.

The effects of engine mixture ratio on c* in terms of a correction appear in Fig. 11.

TABLE 8

INFLUENCE COEFFICIENTS FOR THE YLR79-N/

AND LR101-NA-11 VERNIER ENGINI

A 1% increase in any one of the inde
following percentage change in any o

	Independent Var
1. Atmospheric Pressure, psia	14.696
2. Fuel Density, lb/cu ft	53.170
3. Oxidizer Density, lb/cu ft	71.380
4. Fuel Pump Inlet Pressure, psia	48.000

Dependent Variables	Nominal Values	1
Engine Thrust Without Verniers, pounds	170,000.	-0.1472
Engine Specific Impulse Without Verniers, seconds	252.26	-0.1404
Engine Mixture Ratio With Verniers	2.1500	-0.0001
Engine Fuel Flow With Verniers, lb/sec	217.13	-0.0067
Engine Oxidizer Flow With Verniers, lb/sec	466.83	-0.0068
Vernier Oxidizer Flow, lb/sec	6.4860	-0.0056
Vernier Fuel Flow, lb/sec	3.5637	-0.0058
Vernier Thrust, pounds	2112.0	-0.1702
Thrust Chamber Nozzle Stagnation Pressure, psia	551.53	-0.0069
Fuel Pump Outlet Pressure, psia	901.35	-0.0091
Oxidizer Pump Outlet Pressure, psia	861.27	-0.0089
Pump Speed, rpm	6260.8	-0.0051

1

TABLE 8

; FOR THE YLR79-NA-13 THOR MAIN ENGINE
·11 VERNIER ENGINES (PUMP-FED)

y one of the independent variables causes the
e change in any one of the dependent variables

Independent Variables

14.696	5.	Oxidizer Pump Inlet Pressure, psia	53.000
53.170	6.	c* Correction	1.0000
71.380	7.	Fuel Temperature (at constant density), F	60.000
48.000			

ıal ιes	1	2	3	4	5	6	7
ı00.	-0.1472	-0.6862	1.8030	-0.0178	0.0685	1.0844	-0.0039
:6	-0.1404	-0.0736	0.2228	-0.0017	0.0085	1.1346	-0.0001
ı0	-0.0001	-1.6245	1.6197	-0.0533	0.0614	-0.0374	-0.0256
3	-0.0067	0.5003	0.4707	0.0204	0.0179	-0.0178	0.0138
3	-0.0068	-1.1242	2.0903	-0.0329	0.0794	-0.0552	-0.0119
0	-0.0056	-0.7031	1.6793	-0.0193	0.0563	0.4534	-0.0060
7	-0.0058	0.3569	0.6199	0.0085	0.0256	0.3638	0.0076
0	-0.1702	-0.6315	1.7772	-0.0176	0.0604	0.5157	-0.0046
3	-0.0069	-0.5675	1.5463	-0.0145	0.0588	0.9510	-0.0029
5	-0.0091	-0.3755	1.3415	0.0044	0.0509	0.5976	0.0077
7	-0.0089	-1.0884	2.0517	-0.0304	0.0897	0.6184	-0.0093
8	-0.0051	-0.6687	0.6730	-0.0189	0.0256	0.2659	-0.0061

2

TABLE 9

INFLUENCE COEFFICIENTS FOR THE LR101-NA-11 VERNIER ENGINE OPERATING AT SOLO CONDITIONS

A 1% increase in any one of the independent variables causes the following percentage change in any one of the dependent variables.

Independent Variables

1.	Atmospheric Pressure, psia	14.696	4.	Fuel Propellant Supply Pressure, psia	510.00
2.	Fuel Density, lb/cu ft	50.480	5.	Oxidizer Propellant Supply Pressure, psia	540.00
3.	Oxidizer Density, lb/cu ft	66.270			

Dependent Variables	Nominal Values	1	2	3	4	5
Vernier Thrust, pounds	830.00	-0.2082	0.0358	0.3285	0.0897	0.7599
Vernier Specific Impulse, seconds	198.27	-0.2082	-0.1051	0.1767	-0.2635	0.4086
Vernier Mixture Ratio	1.8000	0.	-0.4947	0.5237	-1.2400	1.2114
Vernier Fuel Flow, lb/sec	1.4951	0.	0.4589	-0.1848	1.1503	-0.4275
Vernier Oxidizer Flow, lb/sec	2.6912	0.	-0.0358	0.3389	-0.0897	0.7839

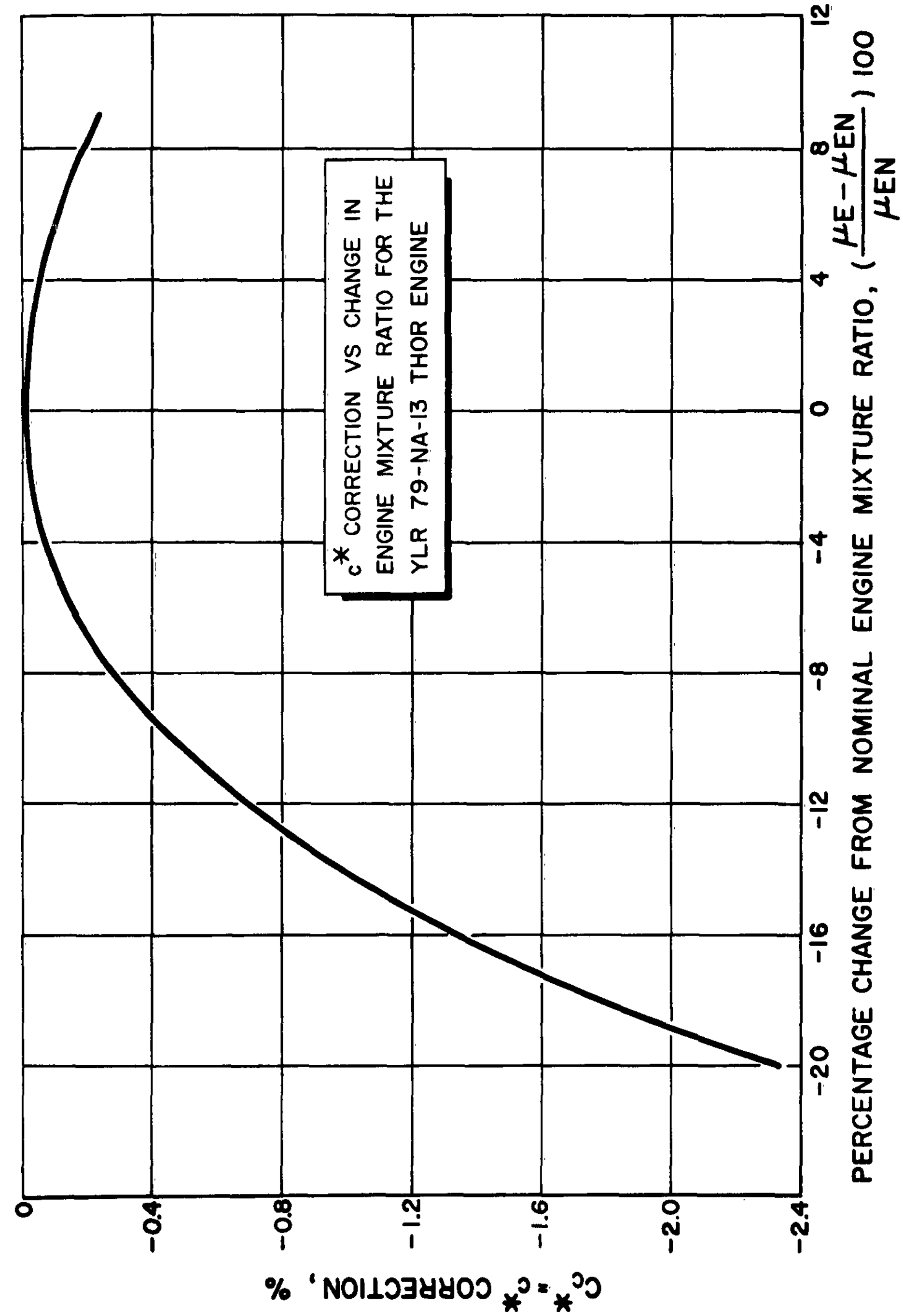


Figure 11. c* Correction vs Change in Engine Mixture Ratio for the YLR79-NA-13 Thor Main Engine

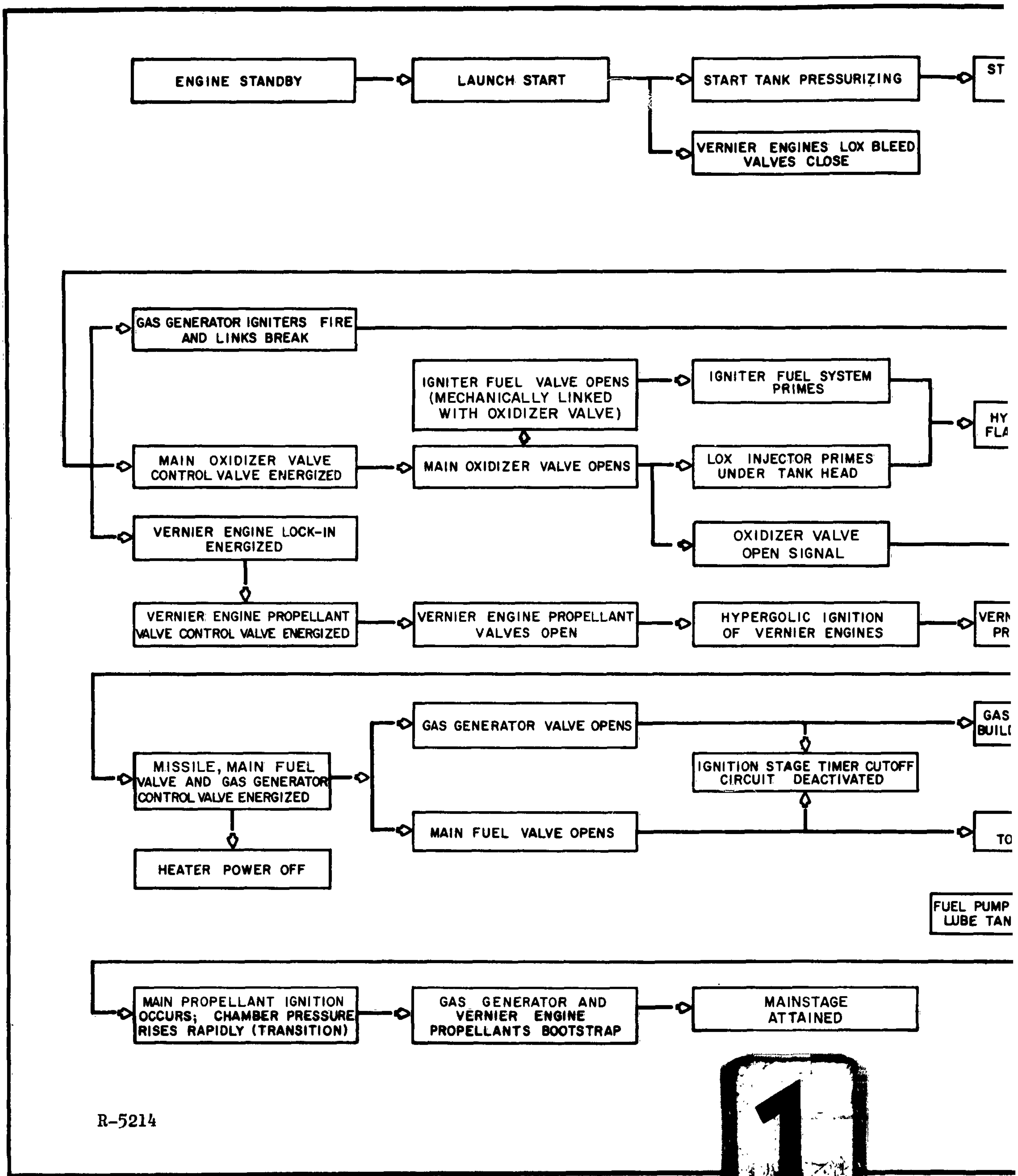
TRANSIENT CHARACTERISTICS

The following portion of this report is devoted to a detailed description of YLR79-NA-13 main engine and LR101-NA-11 vernier engines transient operating characteristics during starting, stabilization, and cutoff. Considered are electromechanical sequencing, engine systems major flows and pressures, and start tanks refill operation. It should be noted that all relationships are typical of static firing operation but are considered good approximations of missile launching conditions as well. Data from simulated missile starts were used where available.

START AND CUTOFF SEQUENCE

The YLR79-NA-13 main engine and LR101-NA-11 vernier engines are electrically sequenced for appropriate start and cutoff operation. All valves are pneumatically operated with a 660 psia regulated gaseous nitrogen supply. Pneumatic restrictors (orifices) are used in conjunction with the valves to provide desired actuation delay and movement times.

Figures 12 and 13 schematically represent electromechanical start and cutoff sequence requirements. Figure 14 displays the average time function of the sequence of events during start and cutoff.


ENGINE STANDBY
LAUNCH START
START TANK PRESSURIZING
ST
VERNIER ENGINES LOX BLEED VALVES CLOSE
GAS GENERATOR IGNITERS FIRE AND LINKS BREAK
IGNITER FUEL VALVE OPENS (MECHANICALLY LINKED WITH OXIDIZER VALVE)
IGNITER FUEL SYSTEM PRIMES
HY FLA
MAIN OXIDIZER VALVE CONTROL VALVE ENERGIZED
MAIN OXIDIZER VALVE OPENS
LOX INJECTOR PRIMES UNDER TANK HEAD
VERNIER ENGINE LOCK-IN ENERGIZED
OXIDIZER VALVE OPEN SIGNAL
VERNIER ENGINE PROPELLANT VALVE CONTROL VALVE ENERGIZED
VERNIER ENGINE PROPELLANT VALVES OPEN
HYPERGOLIC IGNITION OF VERNIER ENGINES
VERN PR
GAS GENERATOR VALVE OPENS
GAS BUIL
MISSILE, MAIN FUEL VALVE AND GAS GENERATOR CONTROL VALVE ENERGIZED
IGNITION STAGE TIMER CUTOFF CIRCUIT DEACTIVATED
MAIN FUEL VALVE OPENS
TO
HEATER POWER OFF
FUEL PUMP LUBE TAN
MAIN PROPELLANT IGNITION OCCURS; CHAMBER PRESSURE RISES RAPIDLY (TRANSITION)
GAS GENERATOR AND VERNIER ENGINE PROPELLANTS BOOTSTRAP
MAINSTAGE ATTAINED

R-5214

1

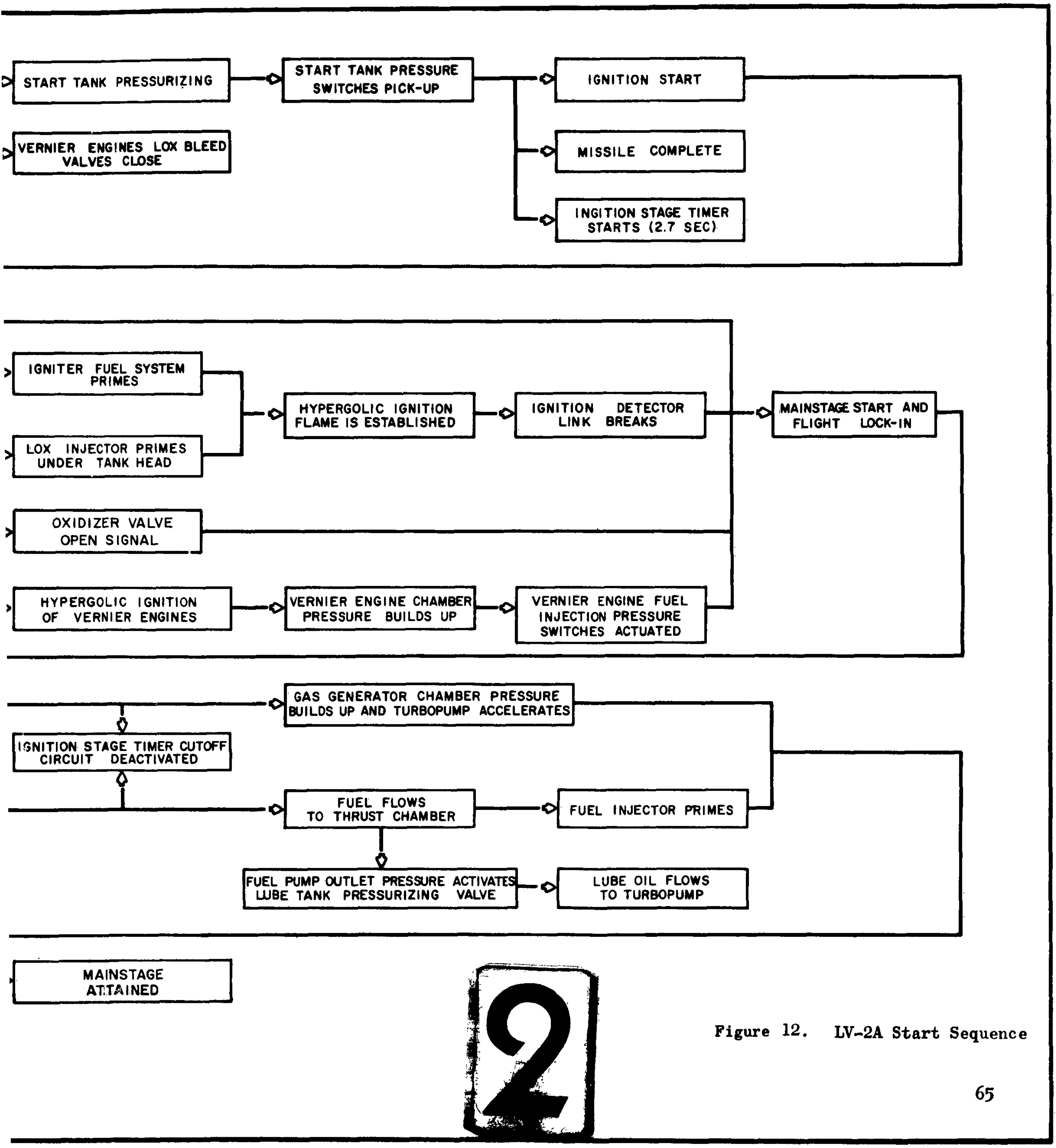


Figure 12. LV-2A Start Sequence

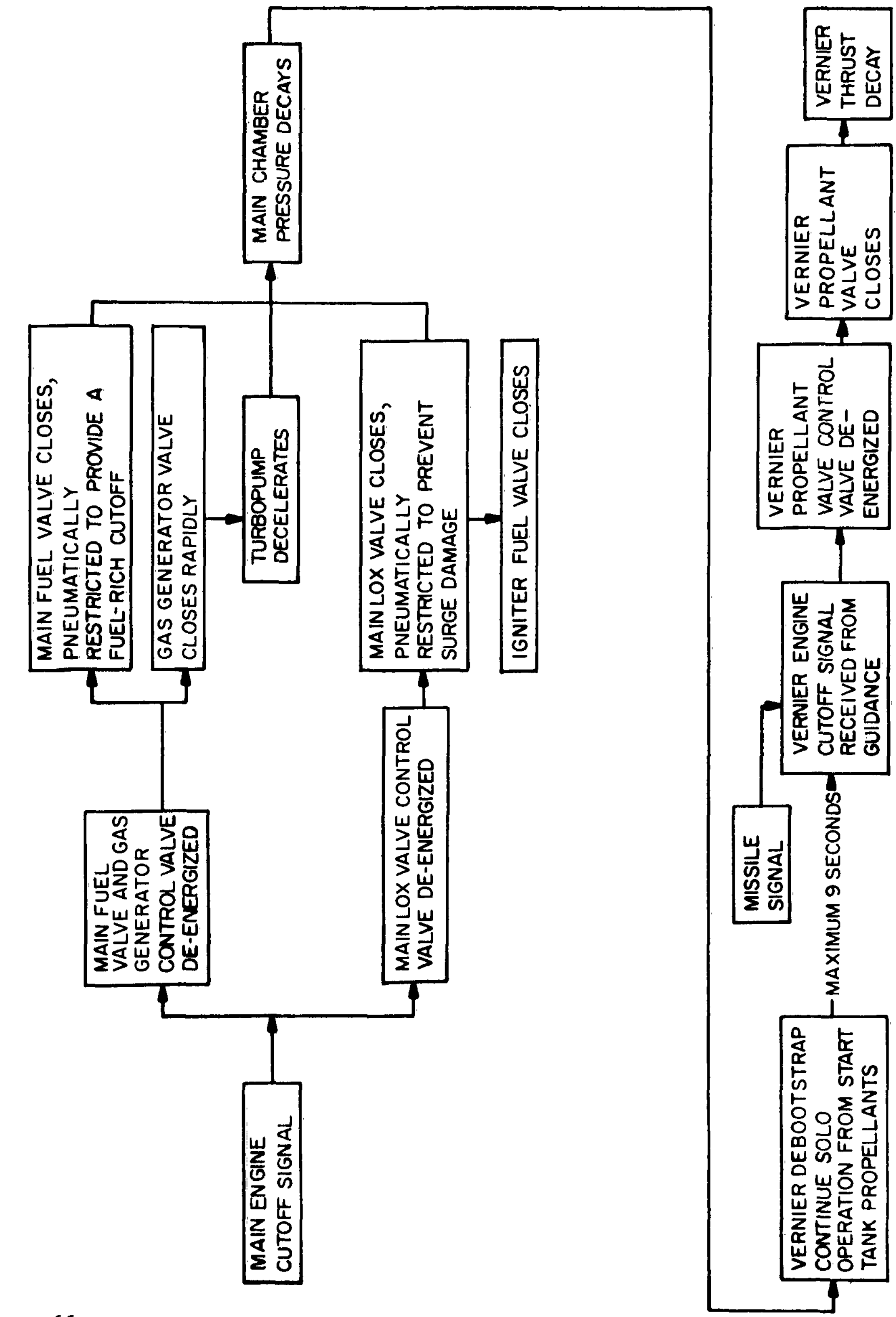
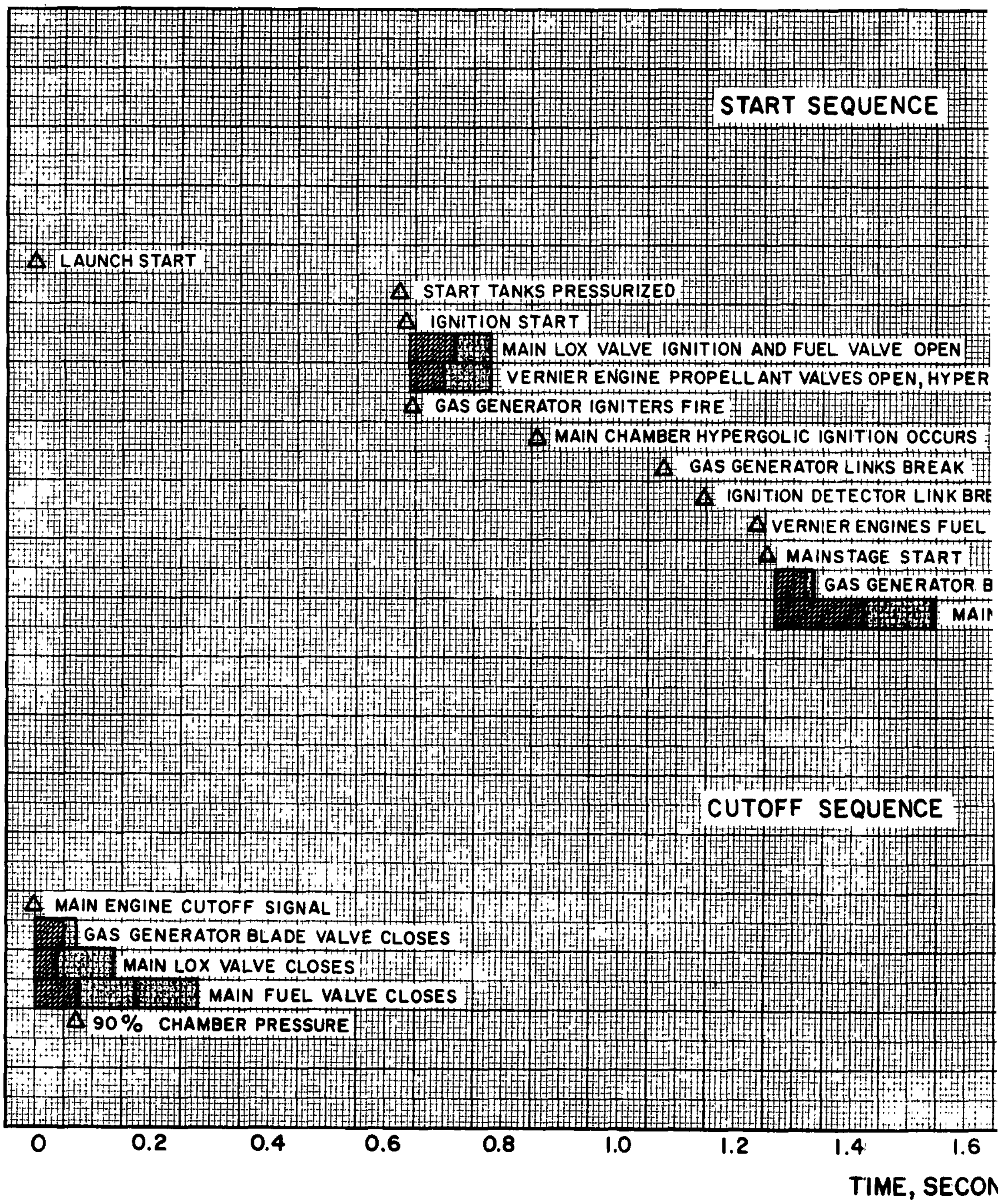


Figure 13. LV-2A Cutoff Sequence


START SEQUENCE
LAUNCH START
START TANKS PRESSURIZED
IGNITION START
MAIN LOX VALVE IGNITION AND FUEL VALVE OPEN
VERNIER ENGINE PROPELLANT VALVES OPEN, HYPER
GAS GENERATOR IGNITERS FIRE
MAIN CHAMBER HYPERGOLIC IGNITION OCCURS
GAS GENERATOR LINKS BREAK
IGNITION DETECTOR LINK BRE
VERNIER ENGINES FUEL
MAINSTAGE START
GAS GENERATOR B
MAI
CUTOFF SEQUENCE
MAIN ENGINE CUTOFF SIGNAL
GAS GENERATOR BLADE VALVE CLOSES
MAIN LOX VALVE CLOSES
MAIN FUEL VALVE CLOSES
90% CHAMBER PRESSURE
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
TIME, SECON

1

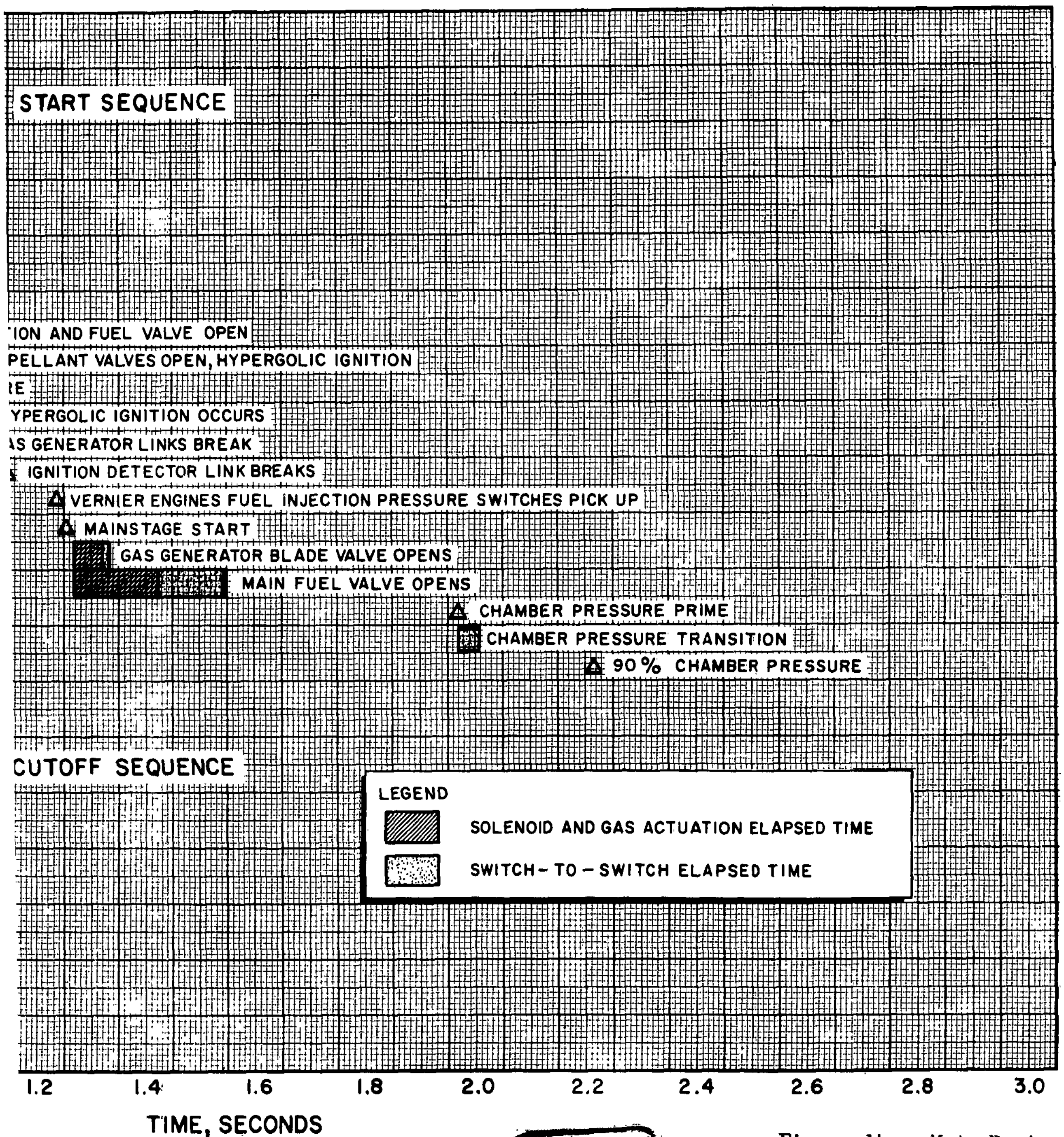


Figure 14. Main Engine Electromechanical Start and Cutoff Time Sequence

START AND CUTOFF TRANSIENT CHARACTERISTICS

The YLR79-NA-13 main engine and LR101-NA-11 vernier engines are ignited by pyrophoric cartridges with an integrated start-vernier solo tank system. Main chamber ignition flame is established by LOX supplied to the injector under tank head, along with start-tank-supplied igniter fuel to spray disks located in each of the six baffled compartments. No chamber fuel jacket prefill is used. Gas generator ignitors are pyrotechnic.

Figures 15 through 17 portray typical start characteristics (primarily propellant flows) of the pump main chamber, and auxilliary systems. Figures 18 and 19 are typical oscillographic recordings (primarily pressures) of an engine start and cutoff, respectively. Vernier engines were simulated during this test. Estimated prelaunch propellant consumption (ignition start to 90% chamber pressure) and start tank refill operation are presented in Tables 10 and 11.

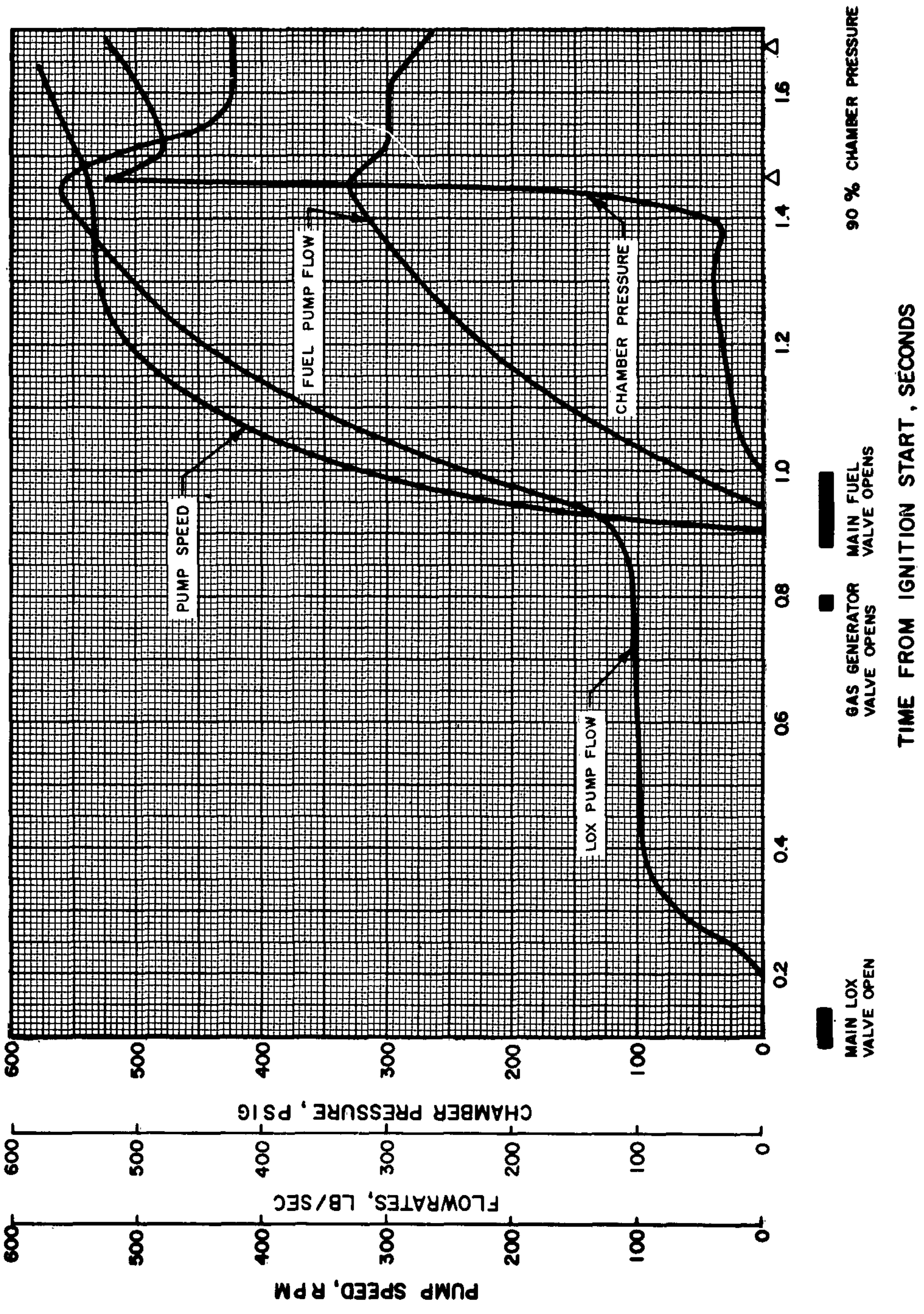


Figure 15. Main Engine System Start Characteristics

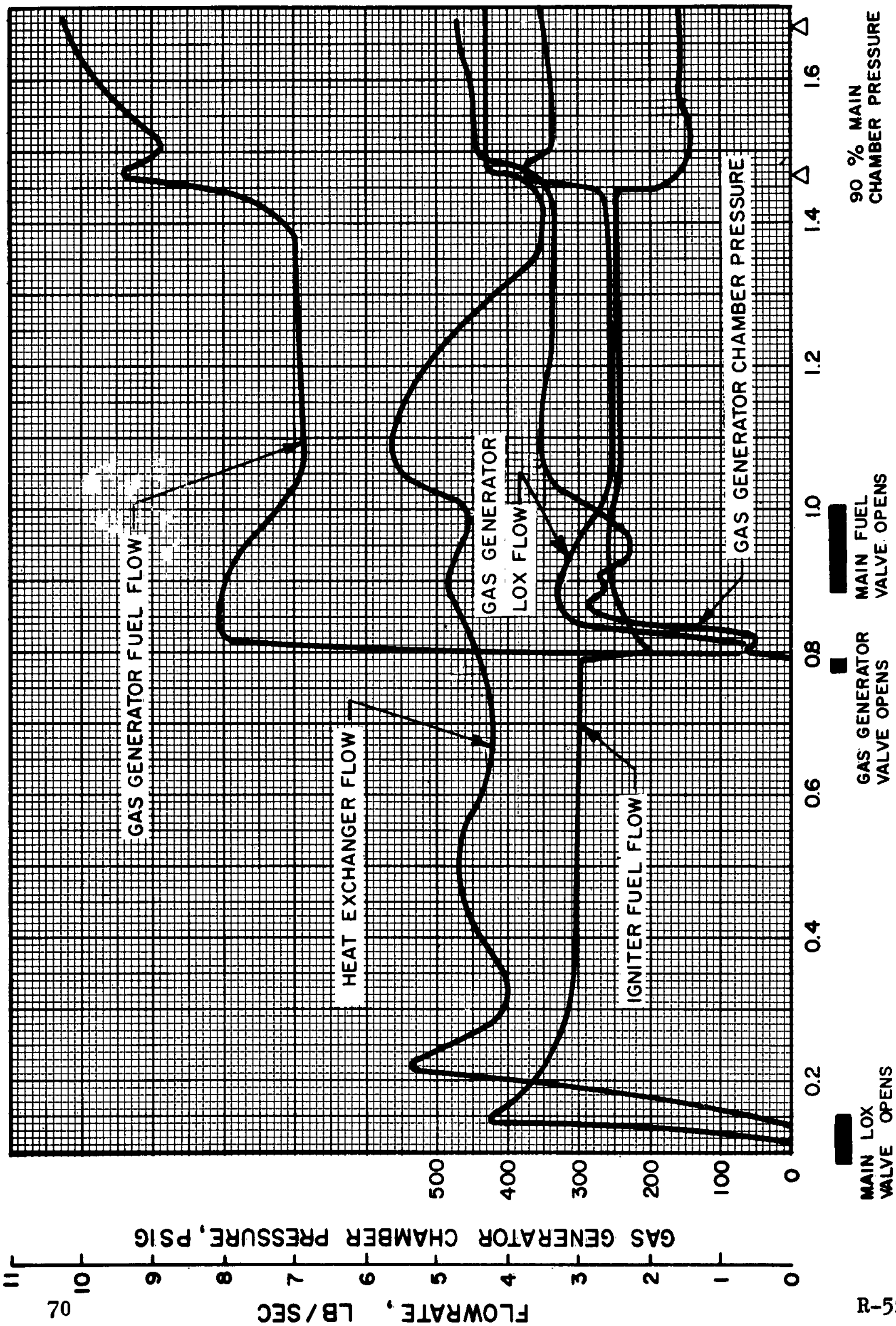


Figure 16. Gas Generator and Auxiliary Flows Start Characteristics

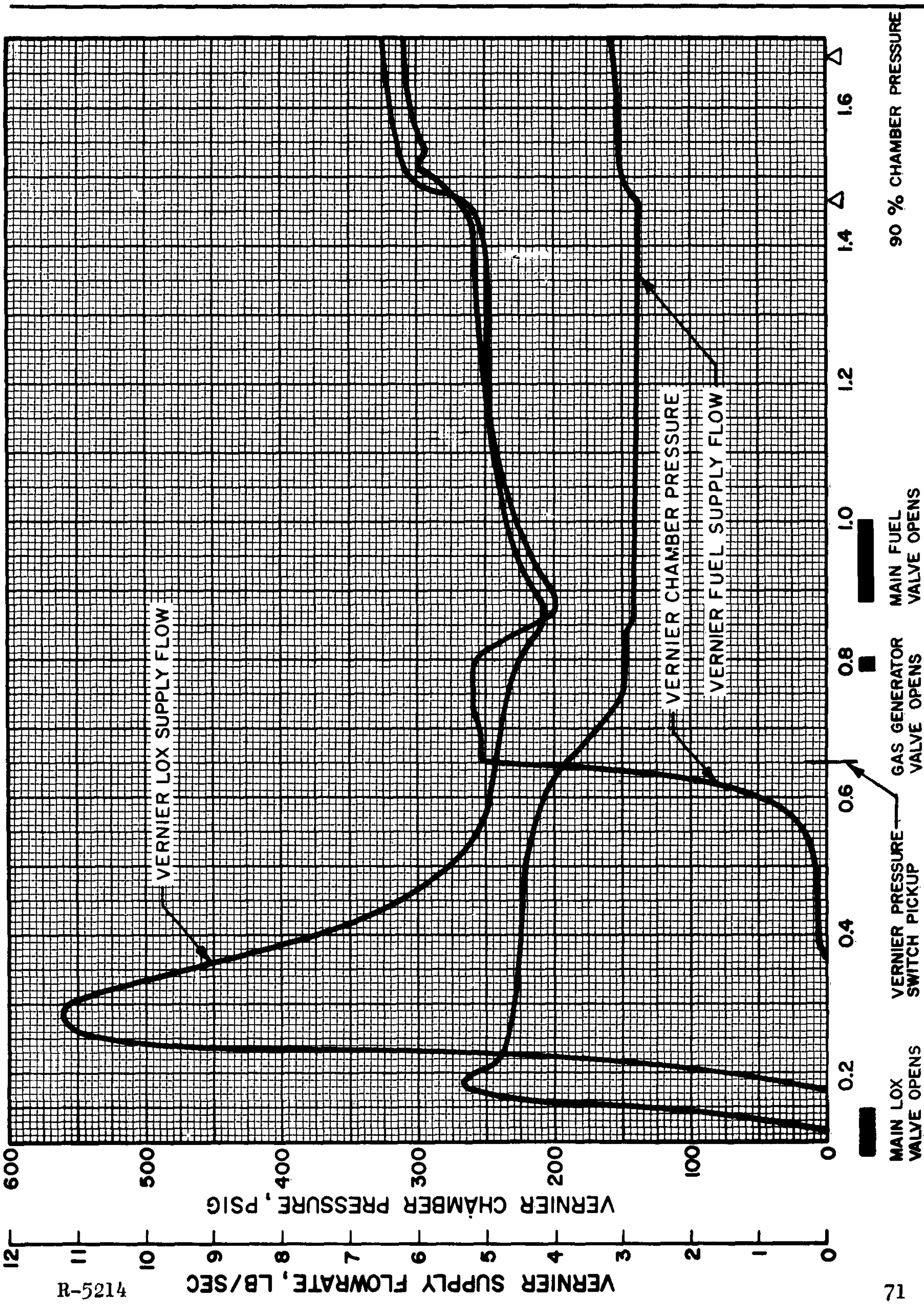
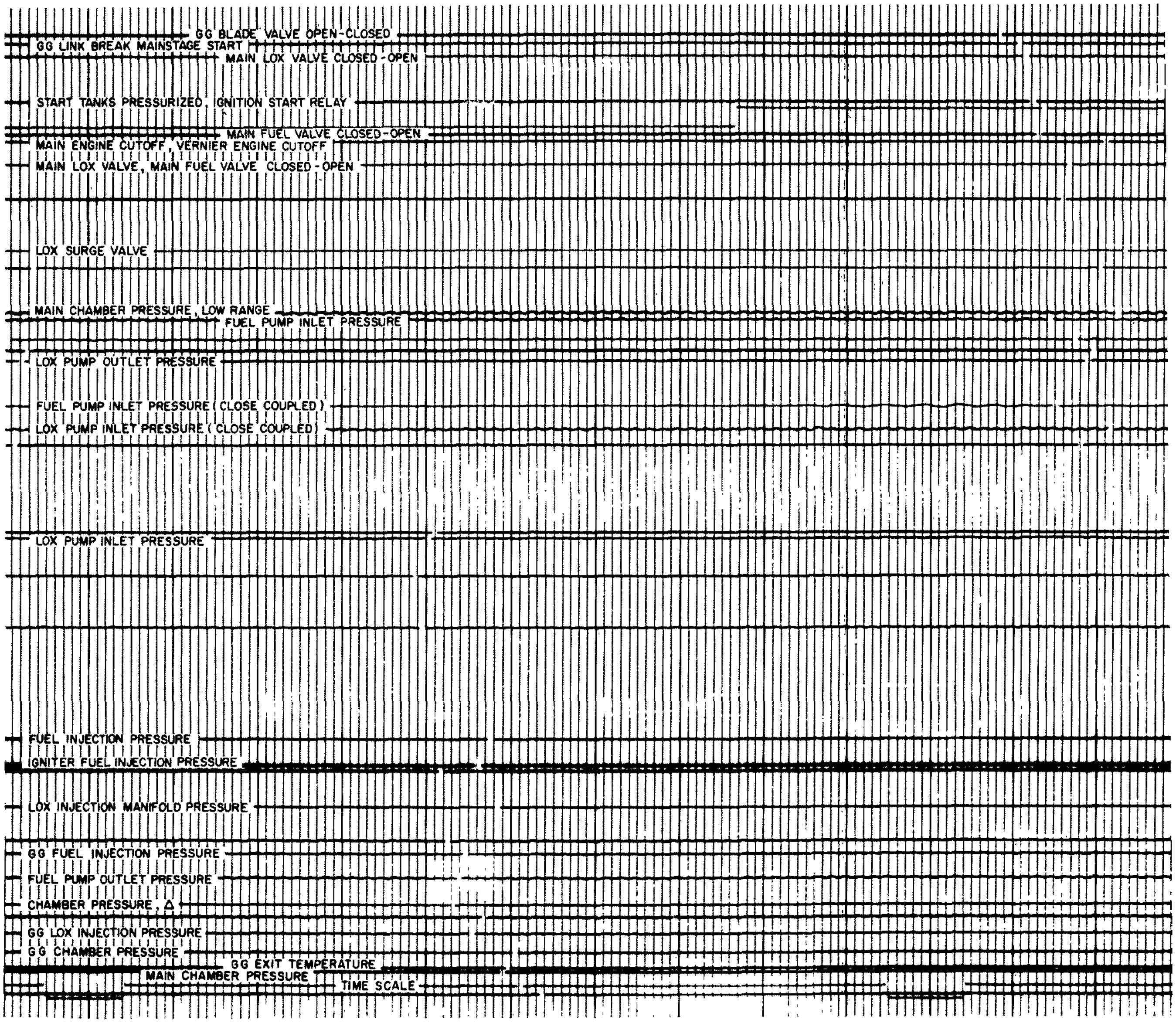
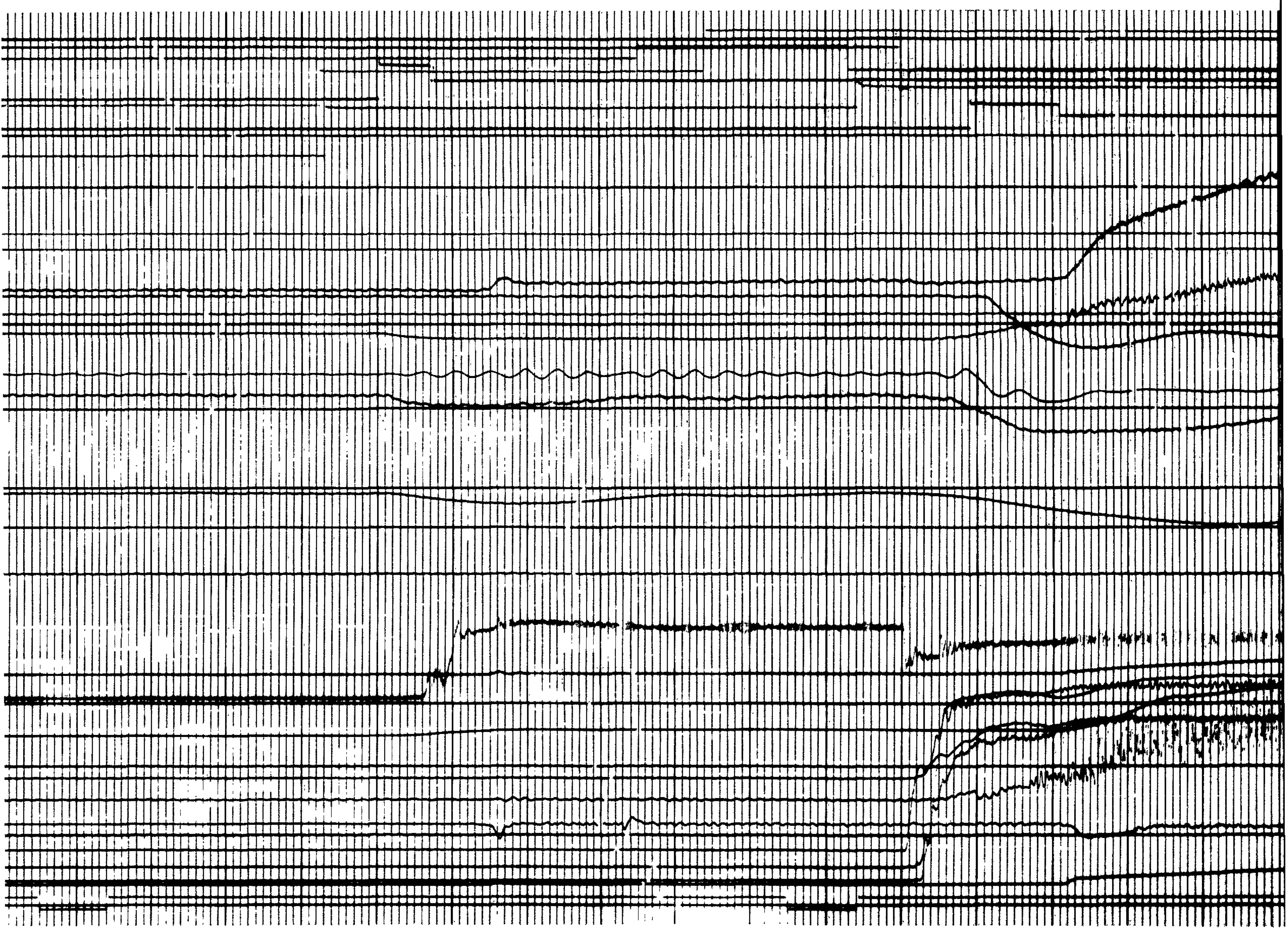


Figure 17. Vernier System Start Characteristics


GG BLADE VALVE OPEN-CLOSED
GG LINK BREAK MAINSTAGE START
MAIN LOX VALVE CLOSED-OPEN
START TANKS PRESSURIZED, IGNITION START RELAY
MAIN FUEL VALVE CLOSED-OPEN
MAIN ENGINE CUTOFF, VERNIER ENGINE CUTOFF
MAIN LOX VALVE, MAIN FUEL VALVE CLOSED-OPEN
LOX SURGE VALVE
MAIN CHAMBER PRESSURE, LOW RANGE
FUEL PUMP INLET PRESSURE
LOX PUMP OUTLET PRESSURE
FUEL PUMP INLET PRESSURE (CLOSE COUPLED)
LOX PUMP INLET PRESSURE (CLOSE COUPLED)
LOX PUMP INLET PRESSURE
FUEL INJECTION PRESSURE
IGNITER FUEL INJECTION PRESSURE
LOX INJECTION MANIFOLD PRESSURE
GG FUEL INJECTION PRESSURE
FUEL PUMP OUTLET PRESSURE
CHAMBER PRESSURE, Δ
GG LOX INJECTION PRESSURE
GG CHAMBER PRESSURE
GG EXIT TEMPERATURE
MAIN CHAMBER PRESSURE
TIME SCALE



2

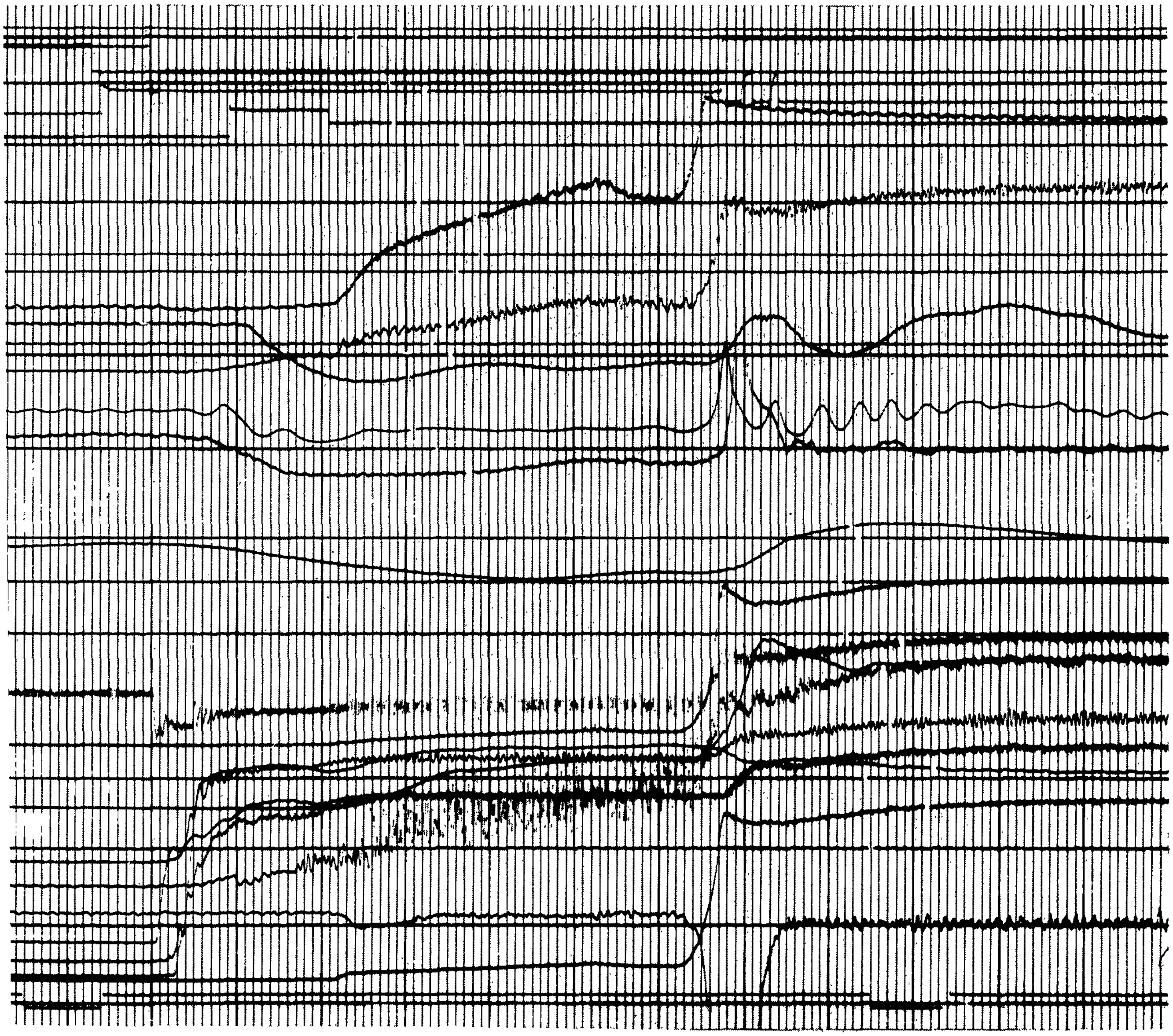
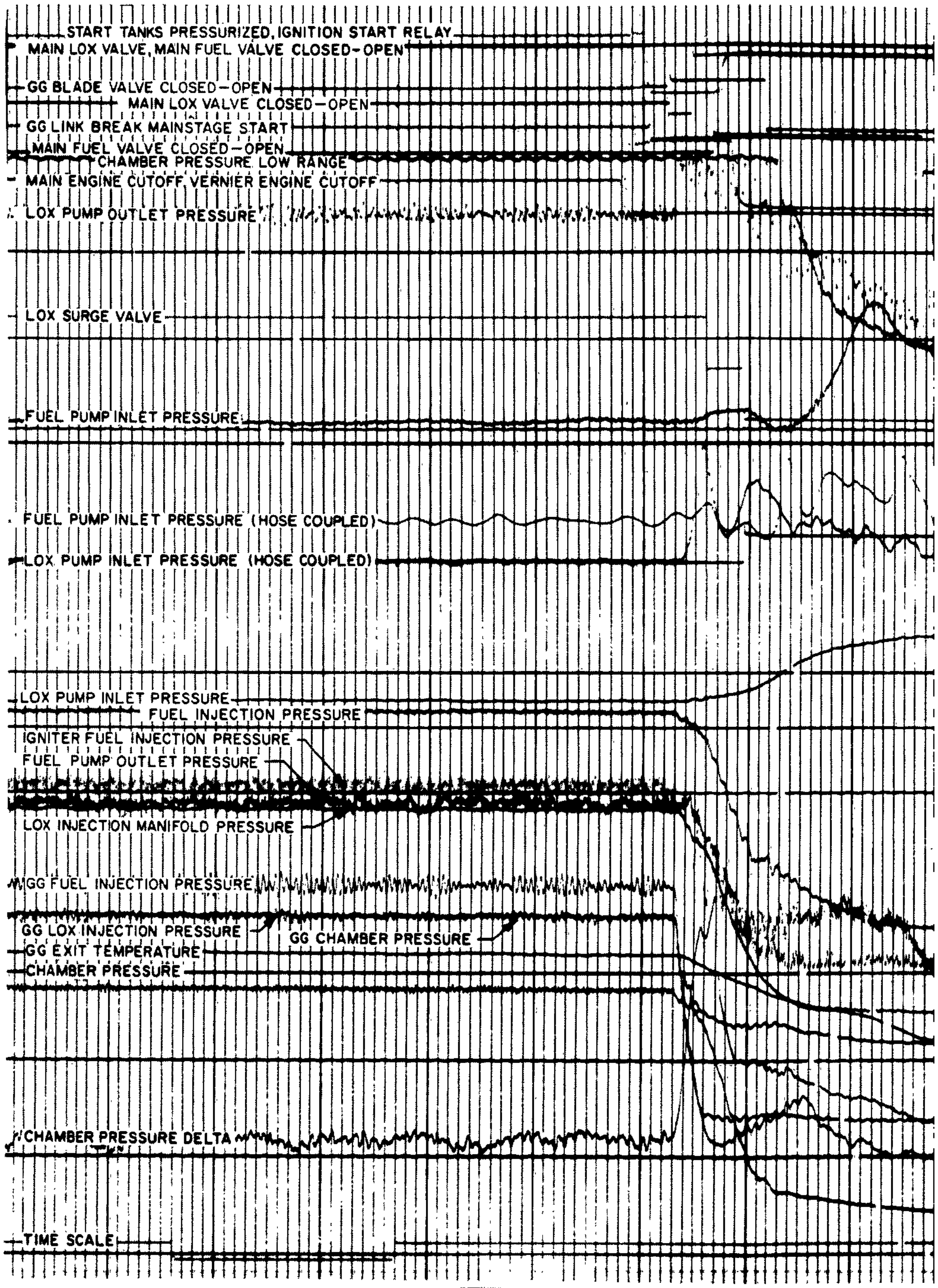
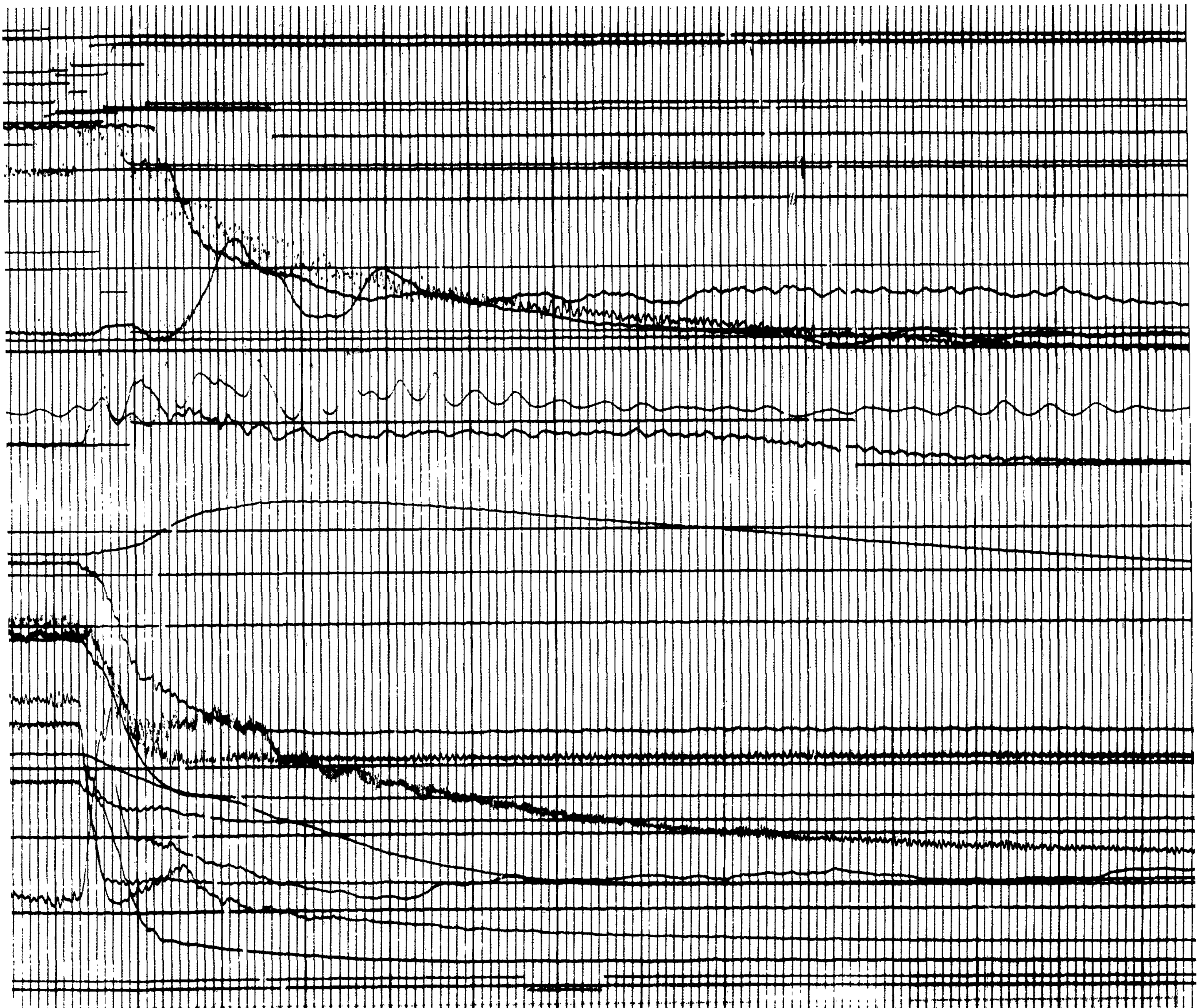


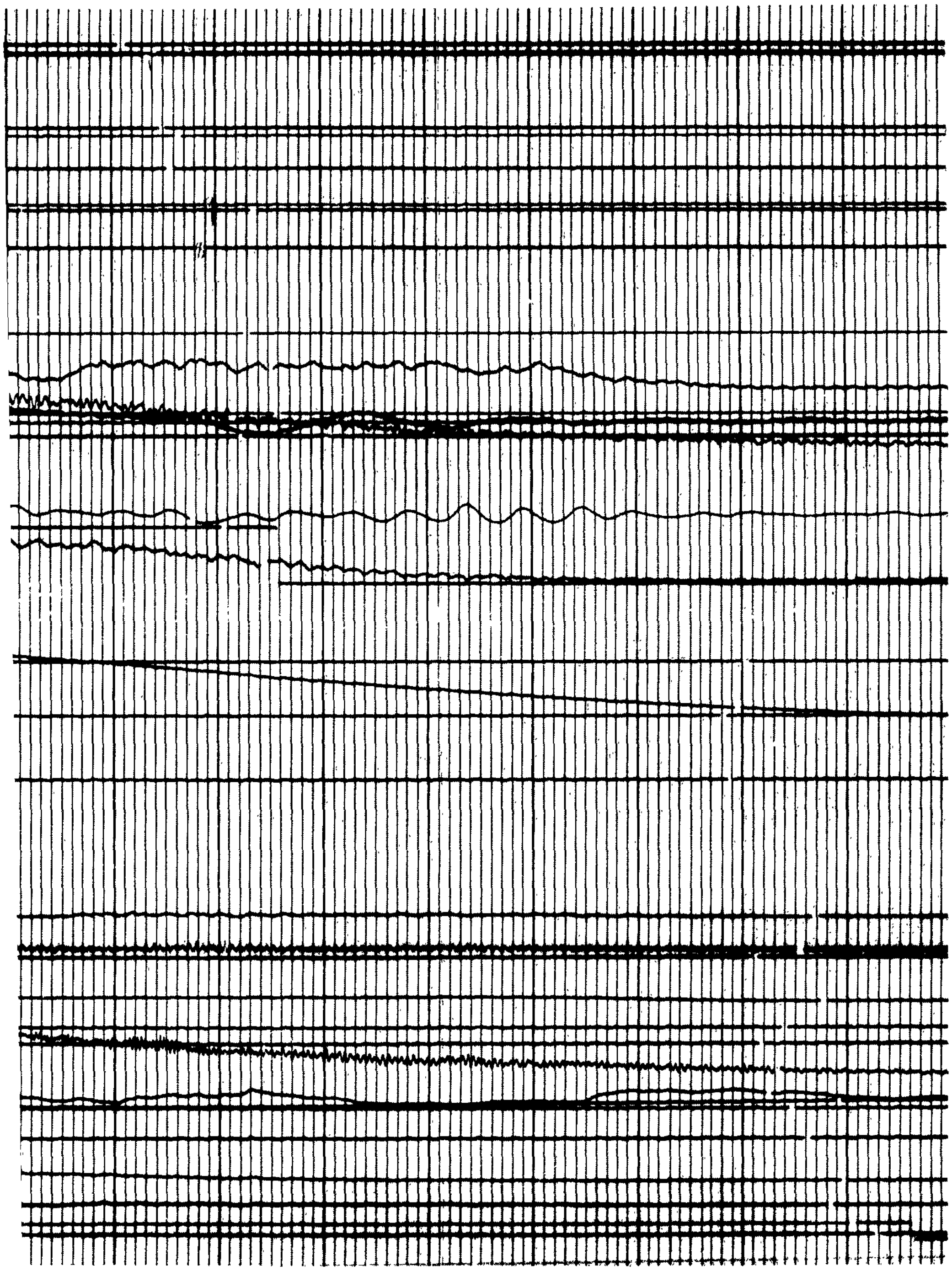
Figure 18. Main Engine Typical Start
Oscillographic Recording


START TANKS PRESSURIZED, IGNITION START RELAY
MAIN LOX VALVE, MAIN FUEL VALVE CLOSED-OPEN
GG BLADE VALVE CLOSED-OPEN
MAIN LOX VALVE CLOSED-OPEN
GG LINK BREAK MAINSTAGE START
MAIN FUEL VALVE CLOSED-OPEN
CHAMBER PRESSURE LOW RANGE
MAIN ENGINE CUTOFF VERNIER ENGINE CUTOFF
LOX PUMP OUTLET PRESSURE
LOX SURGE VALVE
FUEL PUMP INLET PRESSURE
FUEL PUMP INLET PRESSURE (HOSE COUPLED)
LOX PUMP INLET PRESSURE (HOSE COUPLED)
LOX PUMP INLET PRESSURE
FUEL INJECTION PRESSURE
IGNITER FUEL INJECTION PRESSURE
FUEL PUMP OUTLET PRESSURE
LOX INJECTION MANIFOLD PRESSURE
GG FUEL INJECTION PRESSURE
GG LOX INJECTION PRESSURE
GG CHAMBER PRESSURE
GG EXIT TEMPERATURE
CHAMBER PRESSURE
CHAMBER PRESSURE DELTA
TIME SCALE

1



2



3

Figure 19. Main Engine Typical Cutoff Oscillographic Recording

TABLE 10

PRELAUNCH PROPELLANT CONSUMPTION*

System	Propellant	
	LOX, pounds	Fuel, pounds
Vernier	6.17	4.52
Gas Generator	1.94	5.38
Ignition	--	3.12
Total Start Tank	8.11	13.02
Heat Exchanger	6.53	
Main Chamber	305	130

*Based on static test performance with 15 to 30 minute LOX childown

TABLE 11

START TANK REFILL CHARACTERISTICS

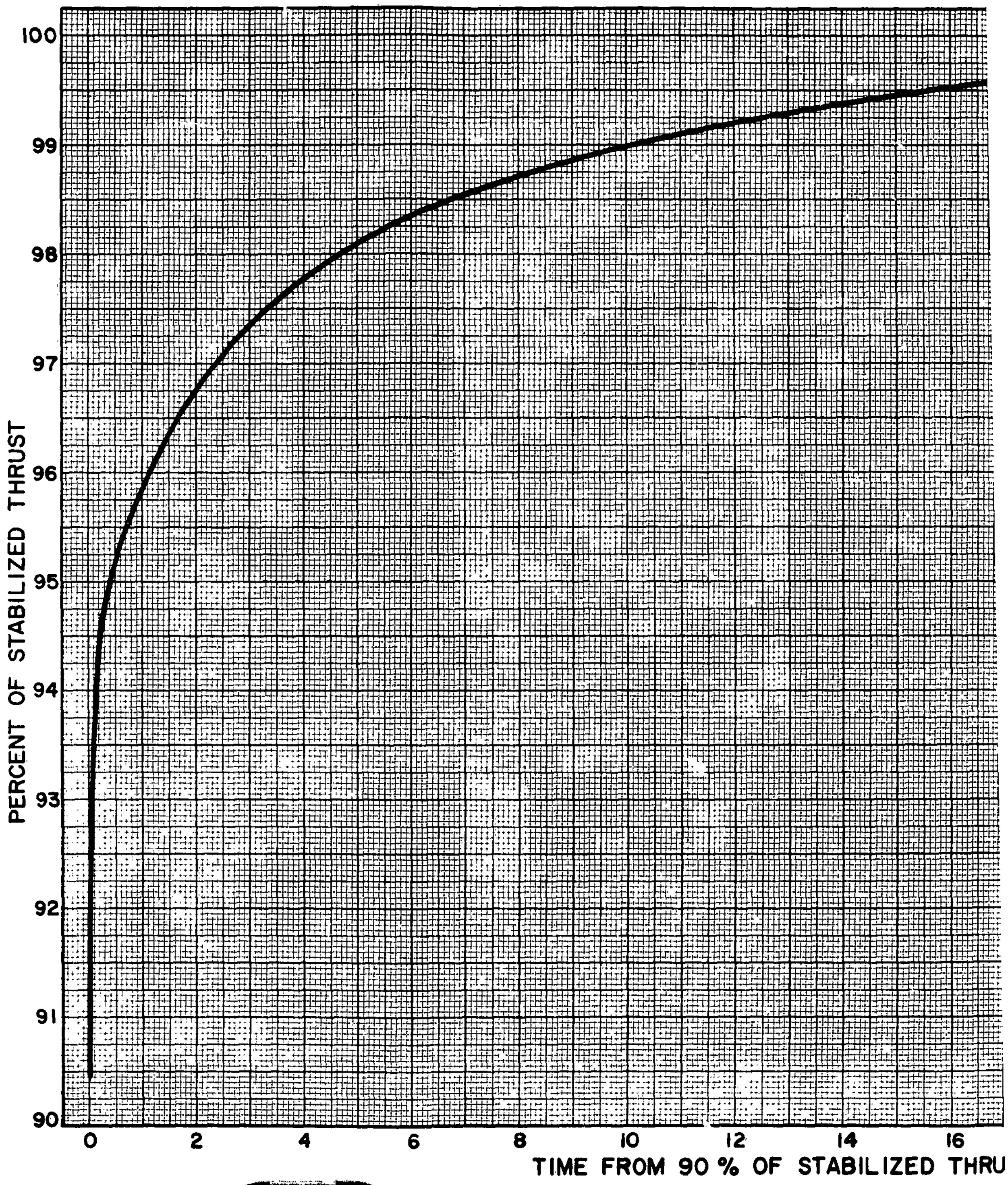
Start Tank	Normal Test Stand Start		Missile Simulated Start		Overboard Flowrate, lb/sec
	Refill Time*, seconds	Refill Rate, lb/sec	Refill Time*, seconds	Refill Rate, lb/sec	
Oxidizer	22	0.37	50	0.19	0.20
Fuel	60	0.20	60	0.20	0.02

*Time from 90% chamber pressure to refill indication

STABILIZATION CHARACTERISTICS

Gradual stabilizing of pressure-flow parameters under self-sustained operating conditions (bootstrapped power package) is a characteristic of liquid propellant engines with orificed control of gas generator propellant supply flows. The main engine generally attains stabilized operation 30 seconds from 90%. Varying test conditions and random engine hardware influences can, however, result in stabilization times ranging from 15 to 35 seconds from 90%.

The average thrust buildup from 90% to stabilized operation is shown in Fig. 20. Figures 21 through 23 present typical pump, chamber, and auxilliary systems stabilization characteristics (including vernier engines). The test from which the latter relationships were obtained stabilized in 20 seconds, which is not an abnormal condition.


PERCENT OF STABILIZED THRUST
100
99
98
97
96
95
94
93
92
91
90
0
2
4
6
8
10
12
14
16
TIME FROM 90 % OF STABILIZED THRU

FORM R 18-G-18

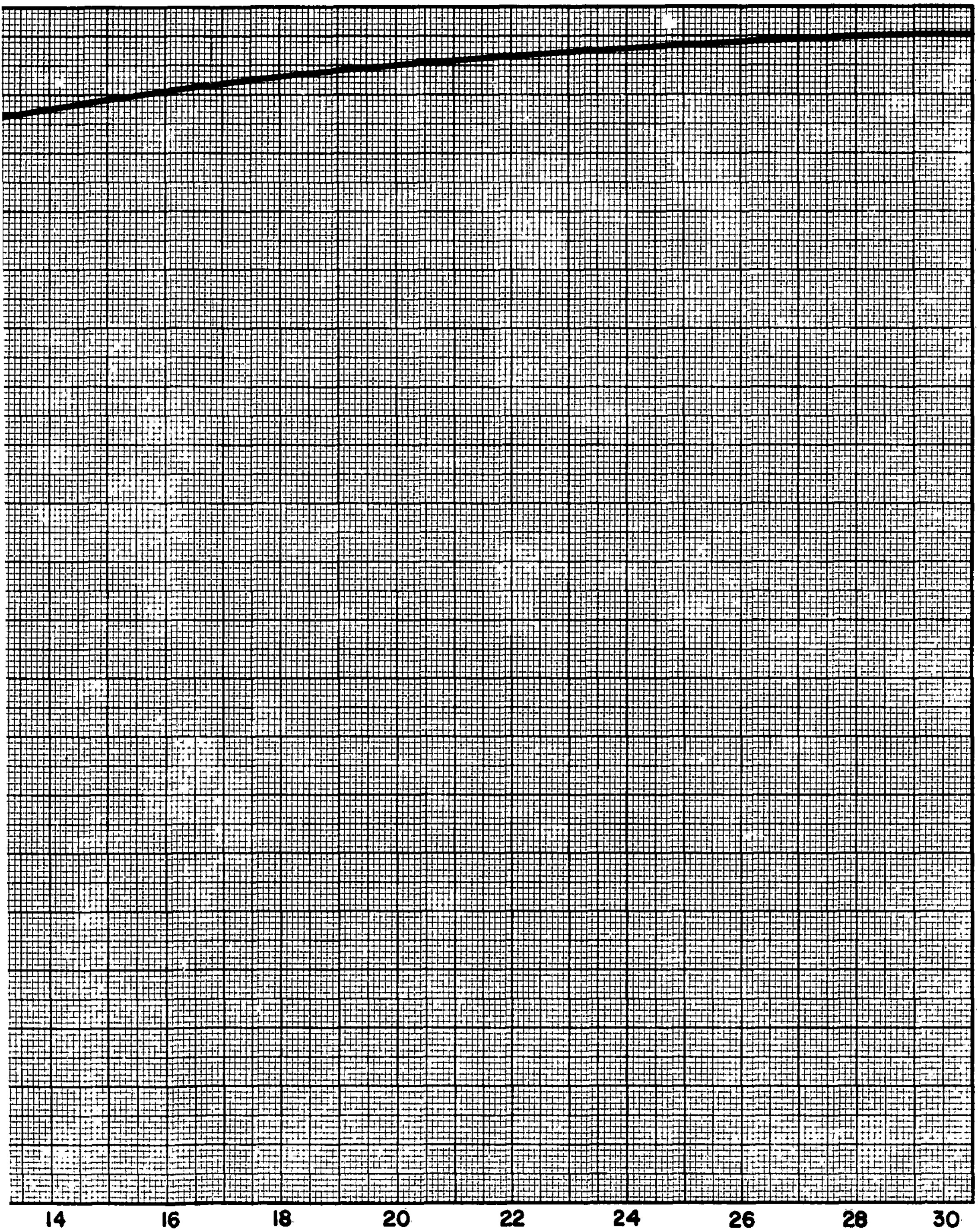
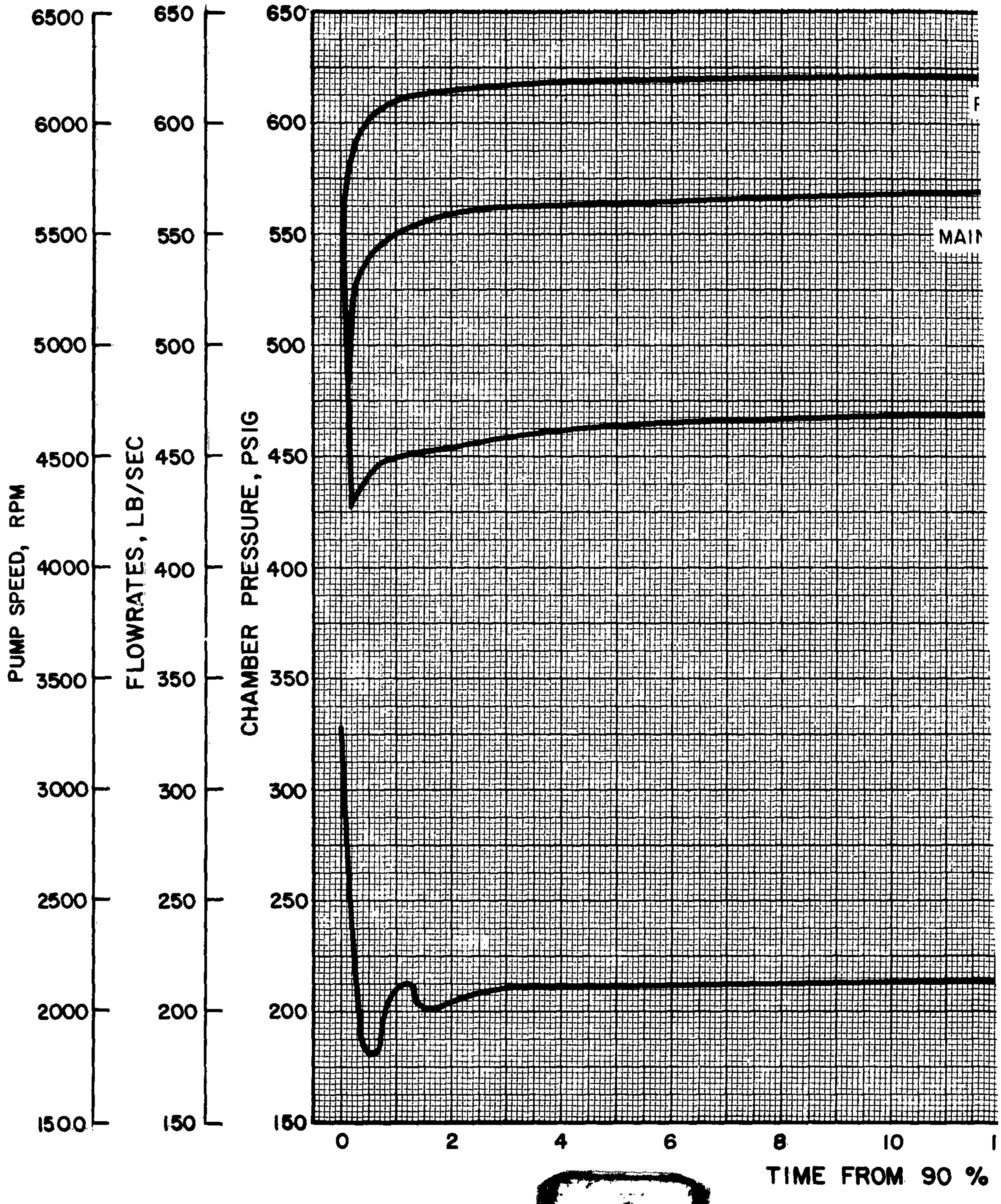


Figure 20. Main Engine Thrust Stabilization Characteristics


PUMP SPEED, RPM
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
FLOWRATES, LB/SEC
650
600
550
500
450
400
350
300
250
200
150
CHAMBER PRESSURE, PSIG
650
600
550
500
450
400
350
300
250
200
150
MAIN
0
2
4
6
8
10
TIME FROM 90 %

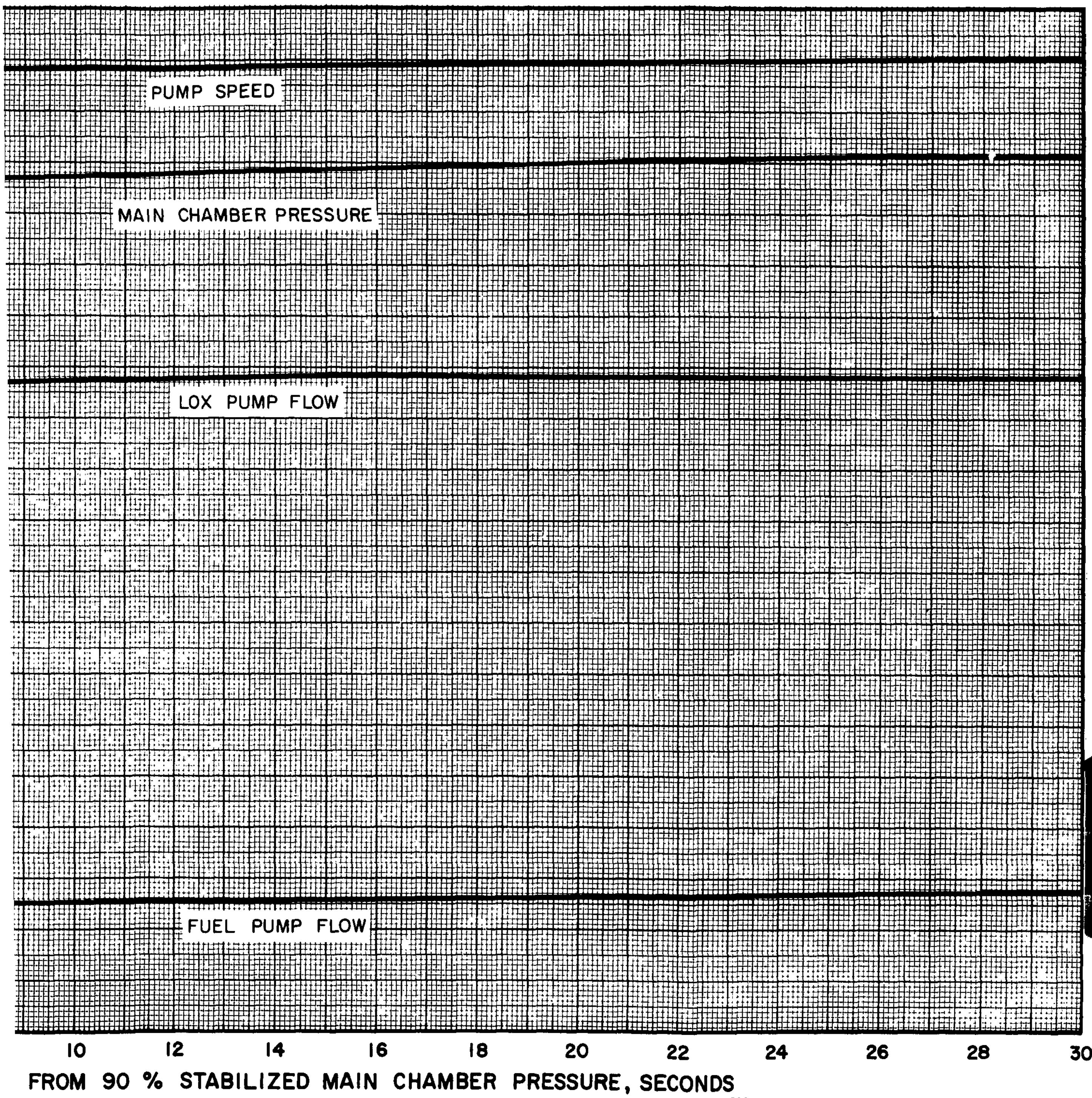
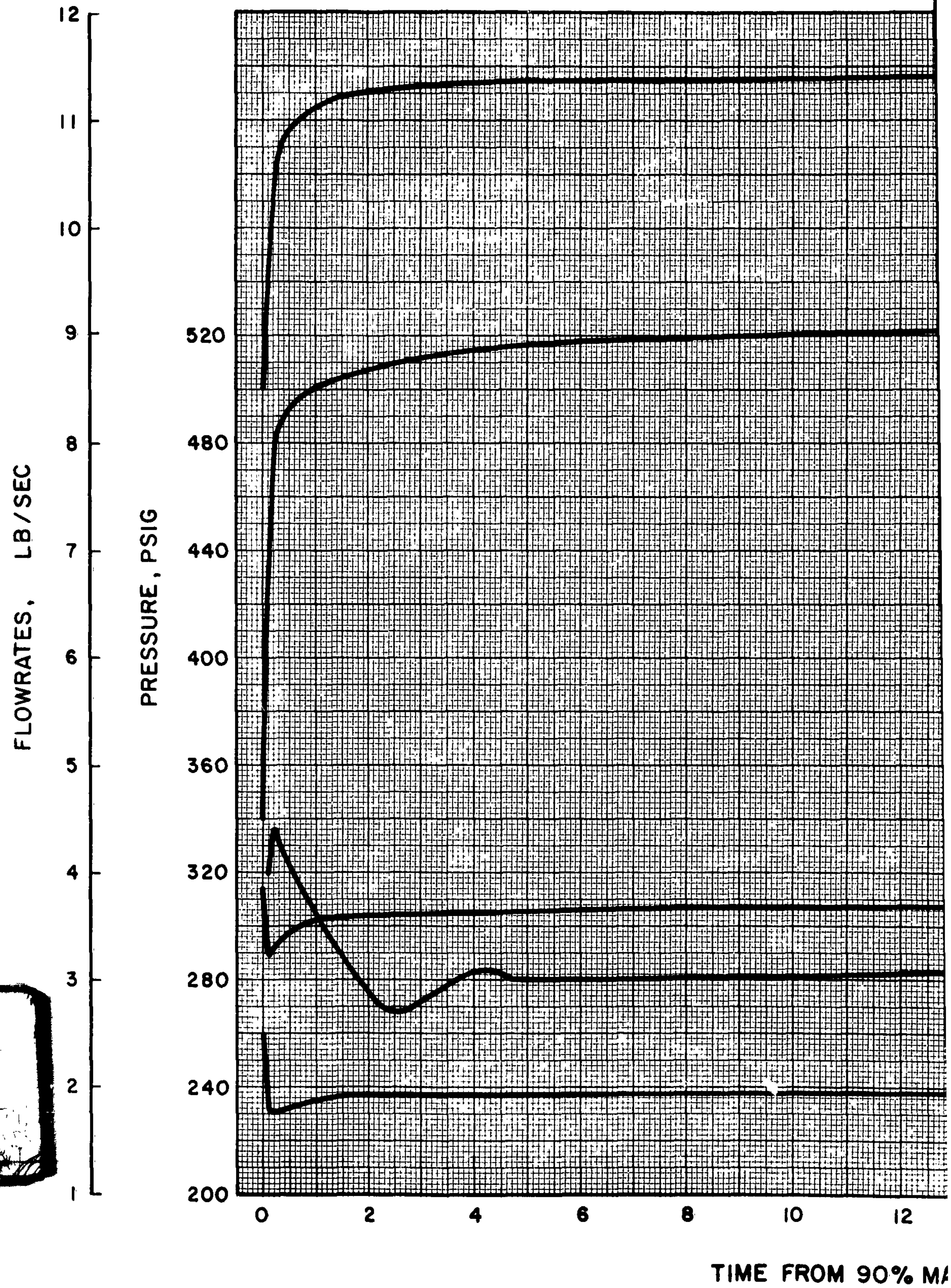


Figure 21. Main Engine System Stabilization Characteristics



FLOWRATES, LB/SEC
PRESSURE, PSIG
12
11
10
9
8
7
6
5
4
3
2
1
520
480
440
400
360
320
280
240
200
0
2
4
6
8
10
12
TIME FROM 90% MA

FORM R 18-G-18

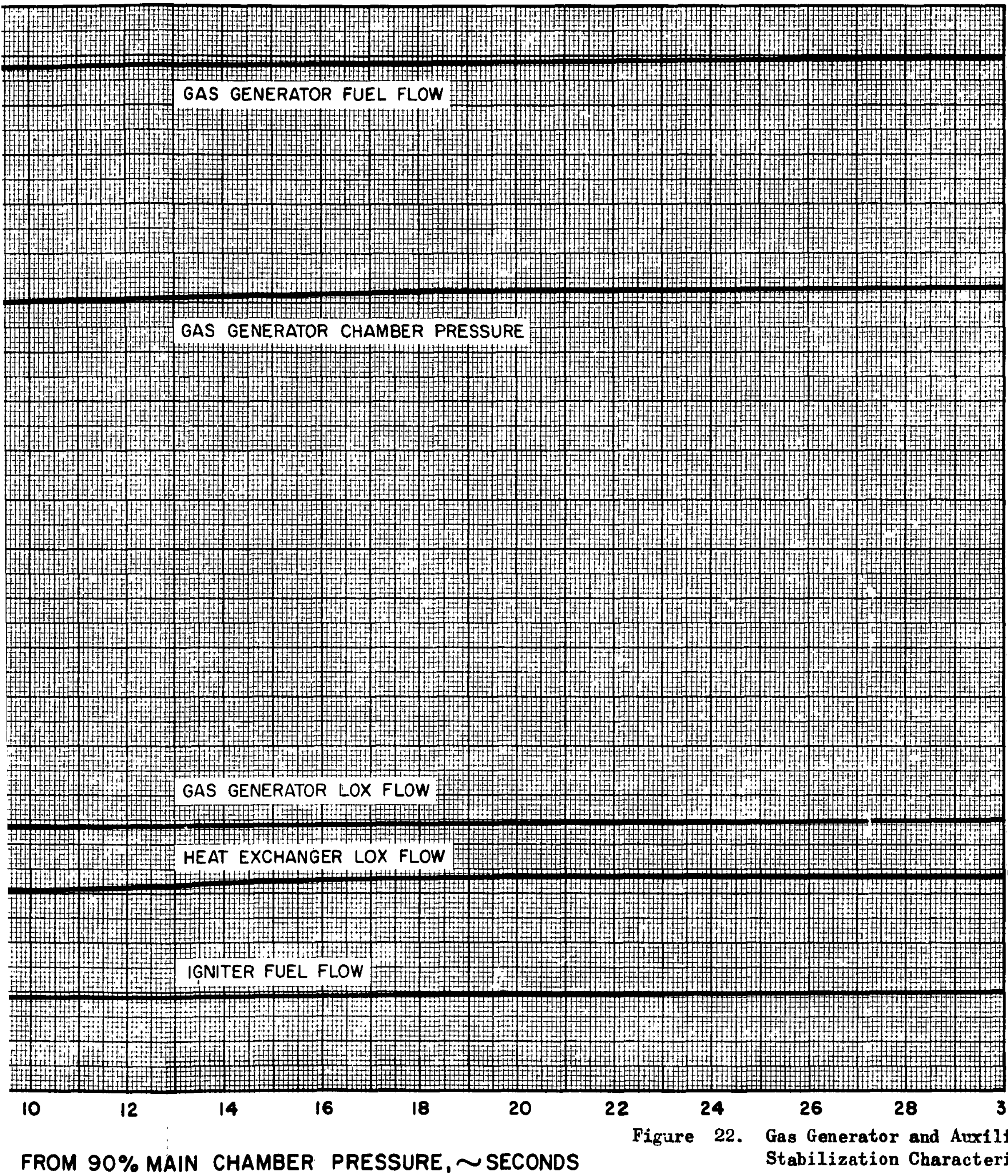
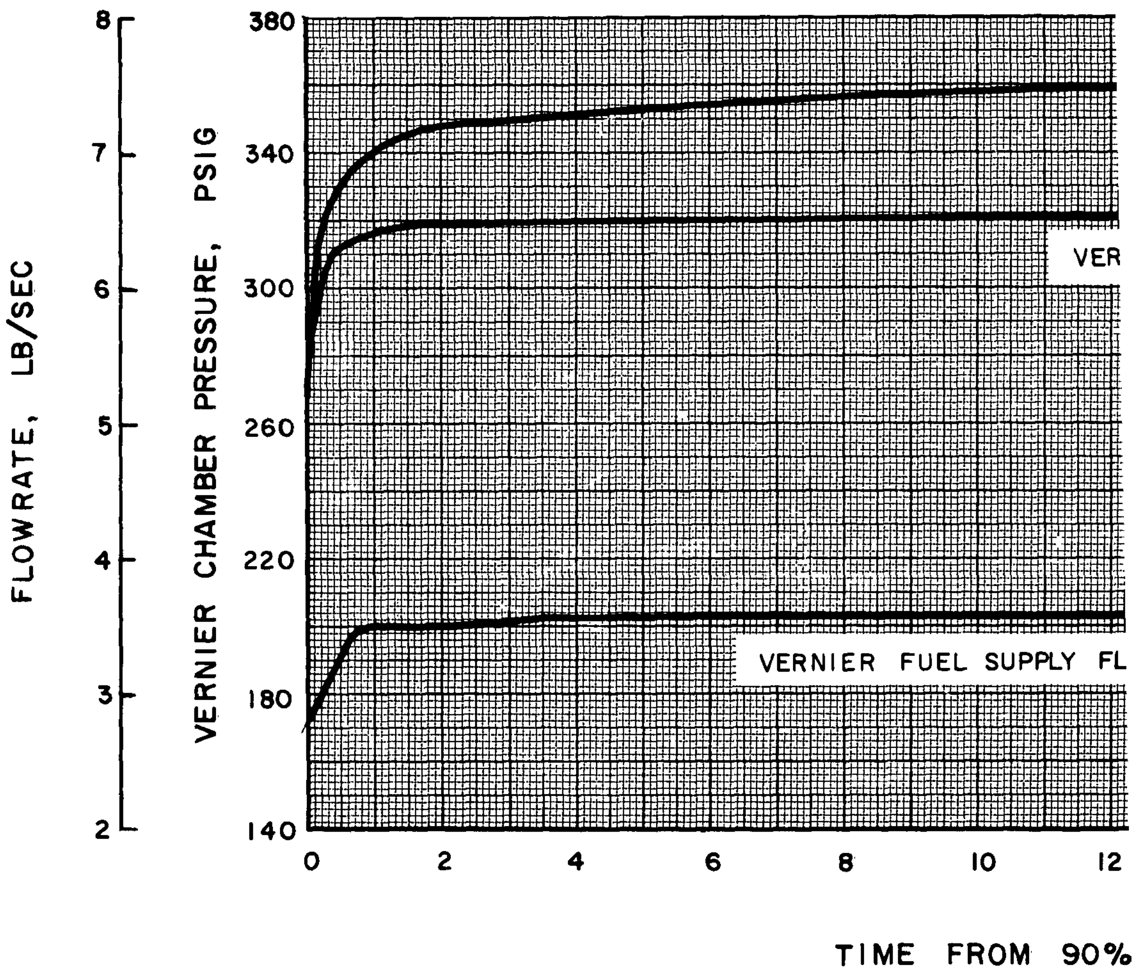


Figure 22. Gas Generator and Auxiliary Flows Stabilization Characteristics


FLOWRATE, LB/SEC
VERNIER CHAMBER PRESSURE, PSIG
8
7
6
5
4
3
2
380
340
300
260
220
180
140
0
2
4
6
8
10
12
VER
VERNIER FUEL SUPPLY FL
TIME FROM 90%

R-5214

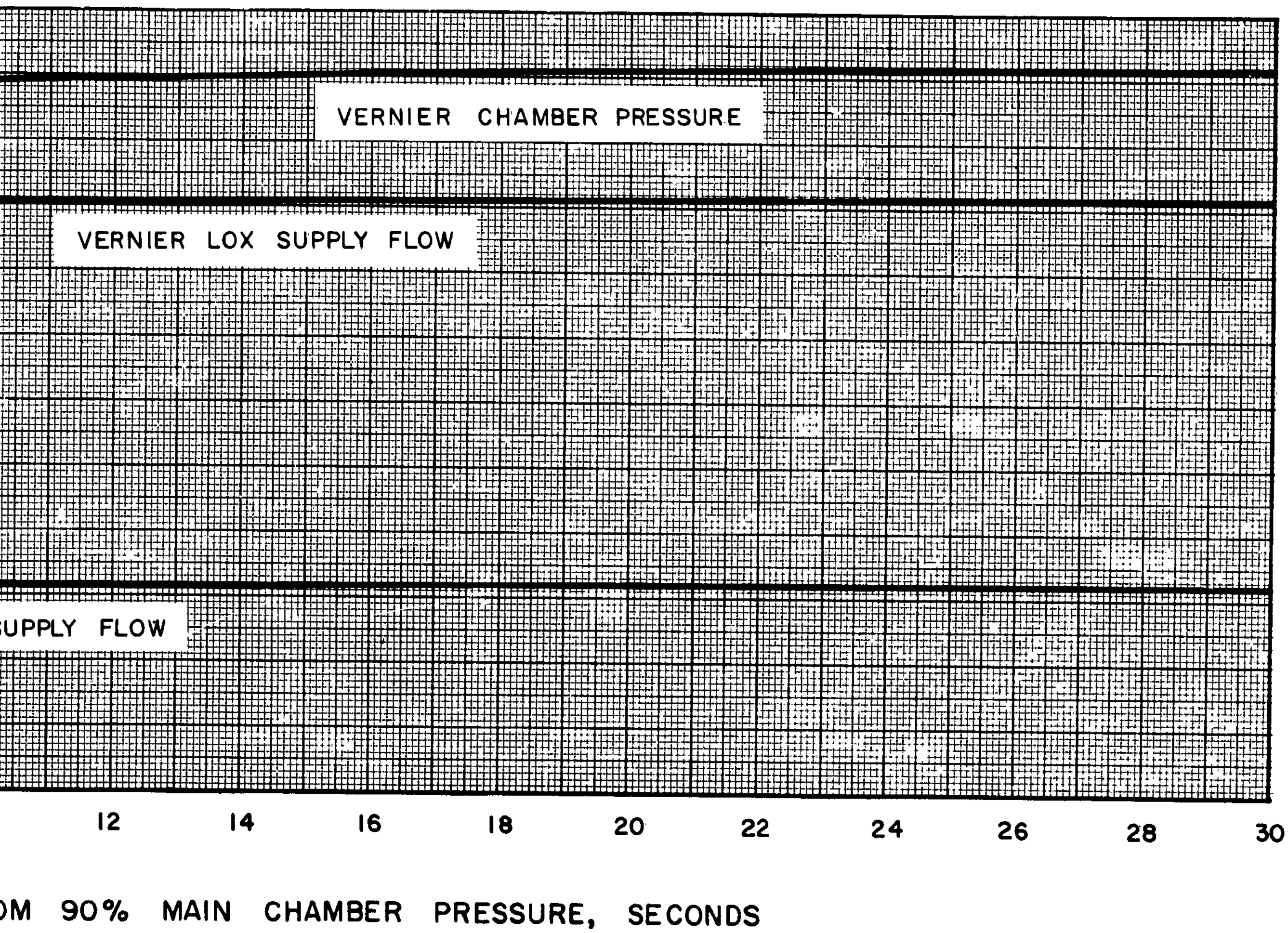


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Figure 23. Vernier System Stabilization Characteristics